INDEXED.

International Marine Engineering

SEPTEMBER, 1912

World's Largest Bulk Freighters Built on the Great Lakes

The freight steamers, *Col. James M. Schoonmaker* and *William P. Snyder, Jr.*, recently built by the Great Lakes Engineering Works, Detroit, Mich., for the Shenango Steamship & Transportation Company, Pittsburg, Pa., are not only the largest bulk freight steamers on the Great Lakes, but they are the largest vessels in the world designed exclusively for carrying freight in bulk.

While these steamers are by no means passenger boats, and no one is carried as a passenger unless specially invited as a guest by the owners of the ships, nevertheless there are provided in the forward deck house for such guests luxurious accommodations which rival the appointments of such magnificent transatlantic express steamships as the *Lusitania* and *Olympic*. The principal dimensions of the vessels are as follows:

Length over all	617 feet.
Length on keel	597 feet.
Beam, molded	64 feet.
Depth, molded	33 feet.
Deadweight carrying capacity at 20-foot draft	13,200 tons.
Water ballast capacity	9,400 tons.
Gross tonnage	15,161
Net tonnage	16,980

The extraordinary development in the construction of Great Lakes bulk freighters in recent years is well known to shipbuilders throughout the world. As has been the custom in recent ships of this type, the hold in these ships is practically an unbroken sweep right forward except for two division bulkheads, almost all of the entire deck being given up to hatches. The hull is of arched girder construction, the cargo hold being divided into three compartments. Hopper sides are carried throughout the hold in a prolonged slope from the tank top to the main deck, forming side tanks 12 feet wide at the bottom and 5 feet wide at the top. It will be seen that notwithstanding the added beam, due to the hopper tanks, the cargo is quite accessible to the unloading machines, owing to the manner in which the side tanks are shaped, confining the cargo easily within the reach of the self-filling buckets, used for unloading bulk cargo, thus entirely eliminating hand shoveling.

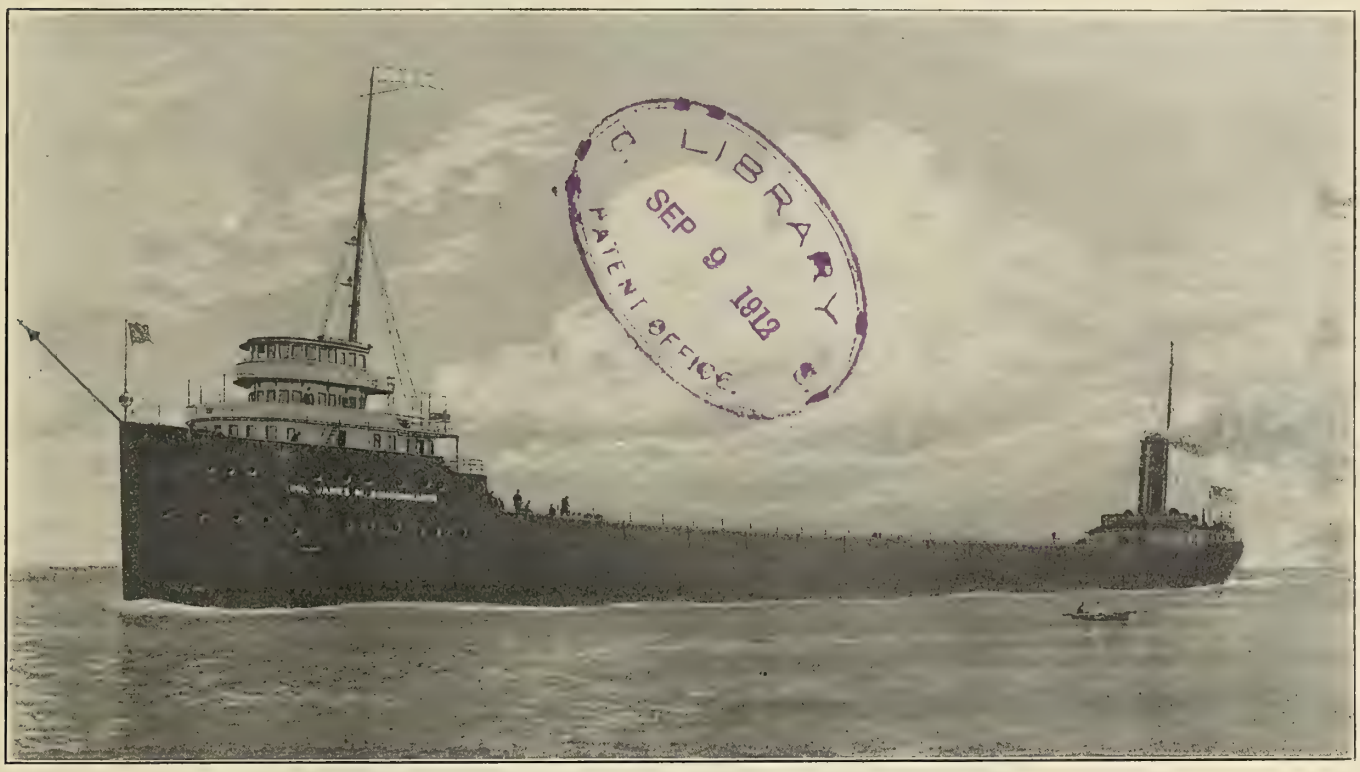

C. LIBRARY SEP 9 1912 PATENT OFFICE.

FIG. 1.—GREAT LAKES BULK FREIGHT STEAMER COL. JAMES M. SCHOONMAKER

Water ballast is carried in the side tanks and in the double bottom, making a total water ballast capacity of 9,400 gross tons. The double bottom is 6 feet deep.

The cargo hatches, which take almost all of the main deck, number thirty-five in all. They are 54 feet wide and 9 feet long, fore and aft. The hatch covers, which are of the steel telescopic type, fitted with steel fasteners, are operated by

wire cables running through portable tripods on deck and fixed cleats in the butt straps, power being supplied by the deck engines.

In construction these steamers are unusually staunch; two extra longitudinal girders have been fitted on the turn of the bilge in the water bottom to secure additional strength. All deck beams run fore and aft, and are 13 inches deep with a 4½-inch flange ⅞ inch thick. All the frames are joggled, thus eliminating the use of liners back of the shell plating. Screen bulkheads are built on the box girder system.

The grate area, with grate bars about 5 feet long, is 55 square feet. Thus the ratio of heating surface to grate area is 47.05 to 1. The draft area through the tubes is 13.28 square feet, thus making the ratio of grate area to draft area 4.14 to 1. The main steam pipe leading from the boilers to the main engine is 8 inches diameter, the main stop valves 6 inches diameter and the auxiliary stop valves 4 inches diameter.

The propelling machinery consists of a vertical inverted quadruple expansion engine, with cylinders 22¾ inches, 33¼

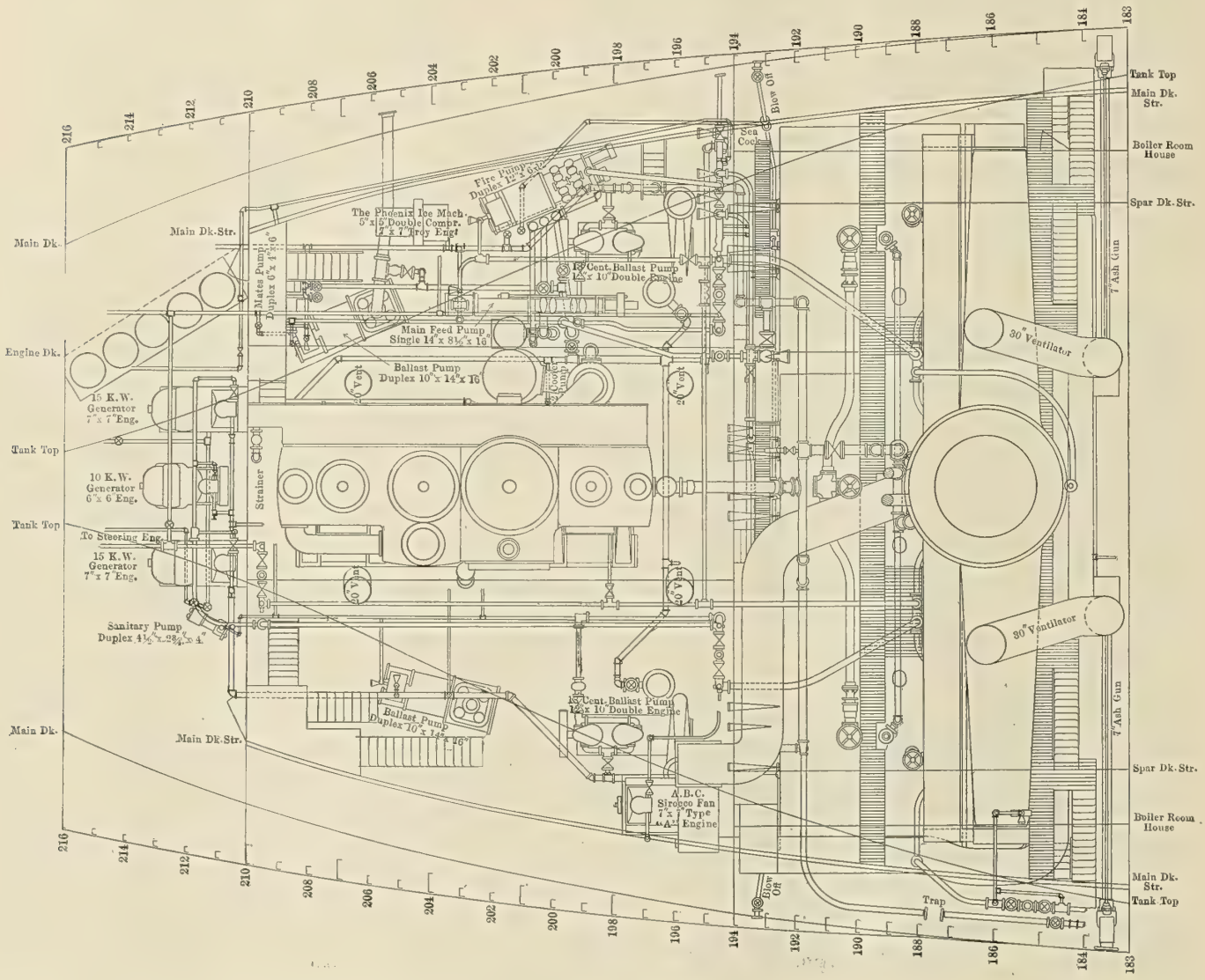

Tank Top
Main Dk. Str.
Boiler Room House
Spar Dk. Str.
Main Dk.
Engine Dk.
Tank Top
Tank Top
Main Dk.
Main Dk. Str.
Spar Dk. Str.
Boiler Room House
Main Dk. Str.
Tank Top
Sea Cock
Blow Off
Fire Pump Duplex 12"x 12"x 12"
The Phoenix Ice Mach. 5"x 5" Double Compr. 7 x 7 Troy Engt
Mates Pump Duplex 6"x 7"x 6"
Main Dk. Str.
15 Cent. Ballast Pump 12"x 10" Double Engine
Main Feed Pump Single 14"x 8½"x 16"
Ballast Pump Duplex 10"x 14"x 16"
20" Vent
Hot Water Tank
20" Vent
15 K.W. Generator 7"x 7" Eng.
10 K.W. Generator 6"x 6" Eng.
Strainer
To Steering Eng.
15 K.W. Generator 7"x 7" Eng.
20" Vent
20" Vent
Sanitary Pump Duplex 4½"x 3¾"x 4"
30" Ventilator
30" Ventilator
7" Ash Gun
7" Ash Gun
15 Cent. Ballast Pump 12"x 10" Double Engine
Ballast Pump Duplex 10"x 14"x 16"
Main Dk. Str.
A.B.C. Sirocco Fan 7'x 7' Type "A" Engine
Blow Off
Trap
216 214 212 210 208 206 204 202 200 198 196 194 192 190 188 186 184 182

FIG. 2.—PLAN THROUGH MACHINERY SPACE

PROPELLING MACHINERY

Steam for the propelling machinery and auxiliaries is provided by three Scotch boilers, 14 feet 9 inches mean diameter, 12 feet 2¼ inches long over all. Each boiler has three corrugated furnaces, 44 inches inside diameter 0.64 inch thick, leading to separate combustion chambers. The safe working pressure allowed is 216 pounds to the square inch. The shell plating of the boilers is 1.6 inches thick. The total heating surface of each boiler is 2,596 square feet, divided as follows:

	Square Feet
Tubes	2,211
Furnaces	140
Combustion chambers	245

inches, 48 inches and 69 inches diameters, with a common stroke of 42 inches. The estimated horsepower of this engine, at about 90 revolutions per minute, is 2,600.

The high-pressure cylinder is placed forward and the first intermediate cylinder aft. The low-pressure cylinder adjoins the high-pressure cylinder, with the second intermediate installed aft of the low-pressure. The high and intermediate cylinders are fitted with piston valves, and the low-pressure cylinder with a double-ported slide valve. The high-pressure and first intermediate-pressure pistons have deep, removable followers, and the second intermediate and low-pressure pistons have special metal packing rings. The piston rods are 5½ inches diameter, fitted into annealed steel crossheads

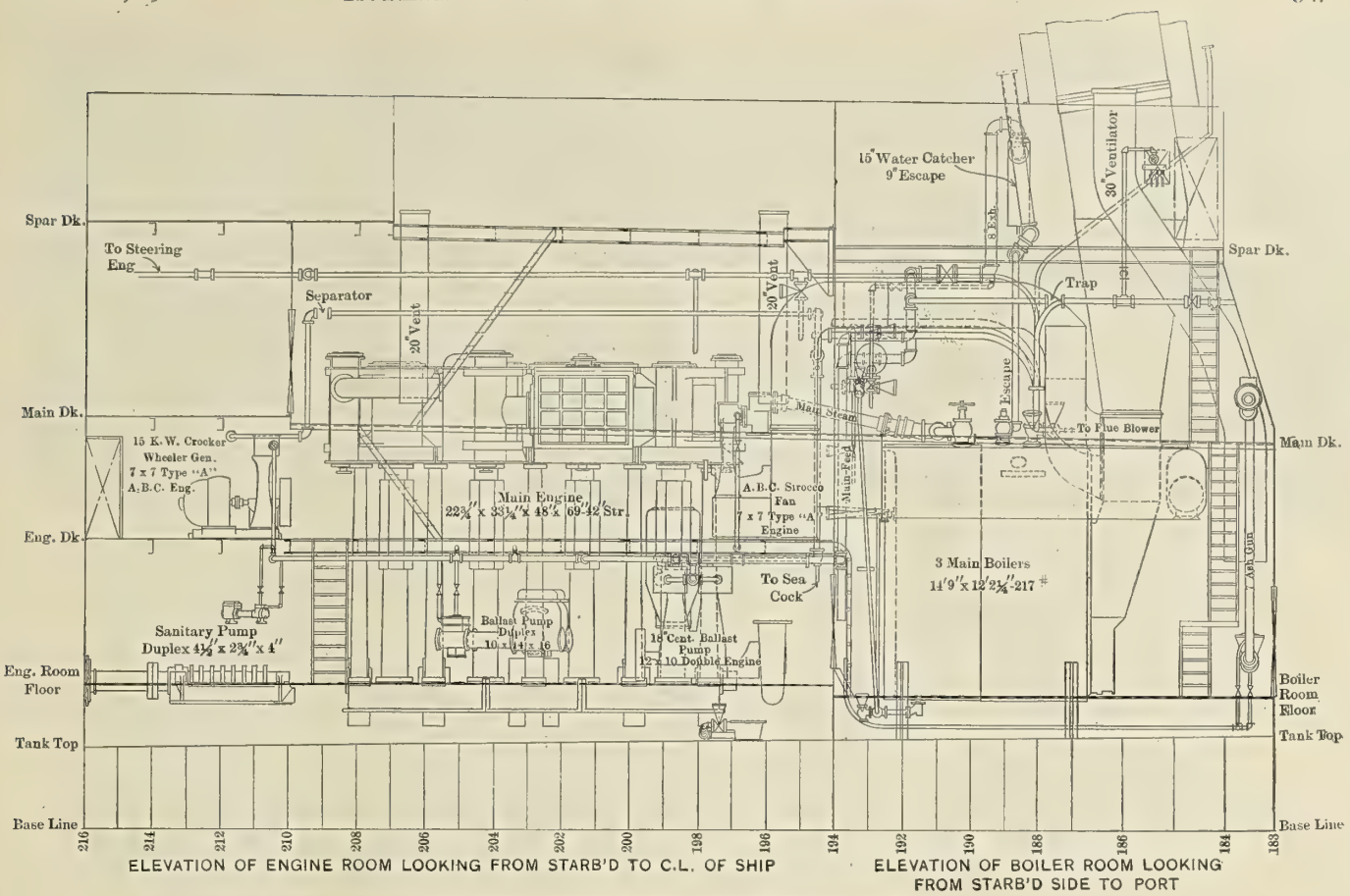

Spar Dk.
Main Dk.
Eng. Dk.
Eng. Room Floor
Tank Top
Base Line
To Steering Eng
Separator
20" Vent
30" Vent
15" Water Catcher
9" Escape
30" Ventilator
Trap
Main Steam
To Flue Blower
15 K.W. Crocker Wheeler Gen. 7 x 7 Type "A" A.B.C. Eng.
Main Engine 22¾" x 33¼" x 48" x 69-42" Str.
A.B.C. Sirocco Fan 7 x 7 Type "A" Engine
Main Feed
To Sea Cock
3 Main Boilers 14'9" x 12'2¾" 217 #
Sanitary Pump Duplex 4½" x 2¾" x 4"
Ballast Pump Duplex 10 x 14 x 16
15" Cent. Ballast Pump 12 x 10 Double Engine
Boiler Room Floor
216 214 212 210 208 206 204 202 200 198 196 194 192 190 188 186 184 183
ELEVATION OF ENGINE ROOM LOOKING FROM STARB'D TO C.L. OF SHIP
ELEVATION OF BOILER ROOM LOOKING FROM STARB'D SIDE TO PORT

FIG. 3.—LONGITUDINAL SECTION THROUGH MACHINERY SPACE

having brass shoes, both for going ahead and astern. The connecting rods are 9 feet long between centers, with brass boxes on top and babbitted cast steel boxes at the lower end. The connecting rods are 5¼ inches diameter at the top and 6½ inches diameter at the bottom. All valves are operated with Stevenson link motion, the low-pressure and second intermediate being operated through rocker arms. Metallic packing is fitted on all valve stems and piston rods. All valves are of ample area, and are accessible for quick overhauling. The crankshaft, which is of the built-up type, with cast steel slabs shrunk on, is 13½ inches diameter, supported in six babbitted journals, two 18 inches and two 22 inches and two 11 inches long. The crankpins are 13½ inches by 12 inches. The thrust bearing is braced to the bed-plate, and has eight driving collars, giving an average working pressure of 40 pounds per square inch.

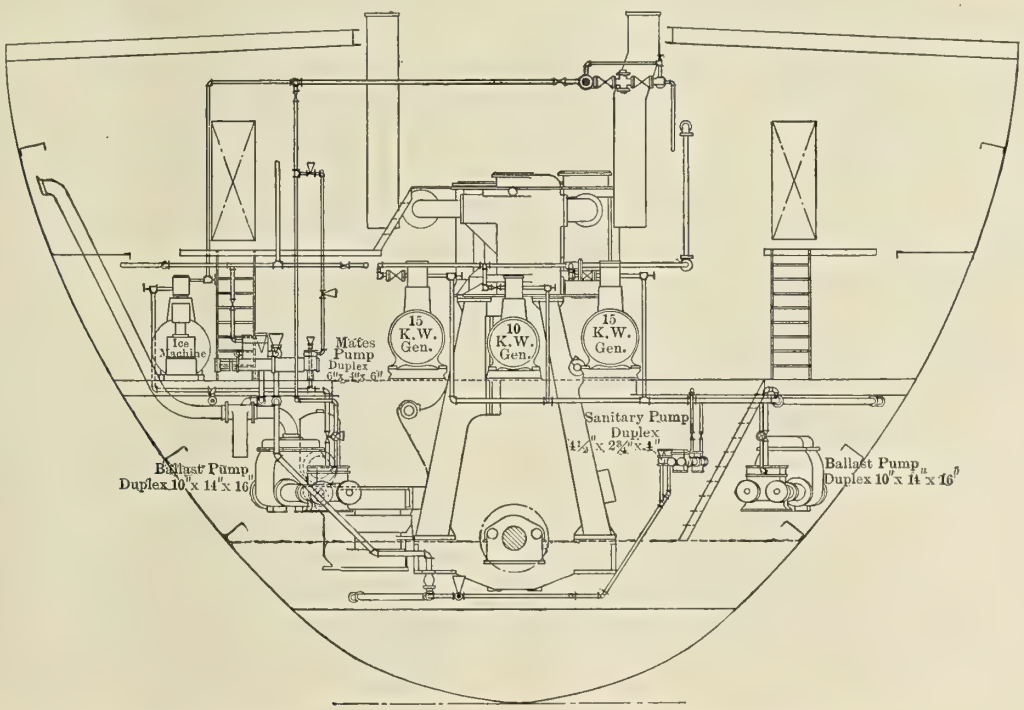

Ice Machine
Mates Pump Duplex 6" x 11" x 6"
15 K.W. Gen.
10 K.W. Gen.
15 K.W. Gen.
Sanitary Pump Duplex 4½" x 2¾" x 4"
Ballast Pump Duplex 10" x 14" x 16"
Ballast Pump Duplex 10" x 14" x 16"

FIG. 4.—SECTION THROUGH ENGINE ROOM ON FRAME NO. 204, LOOKING FORWARD

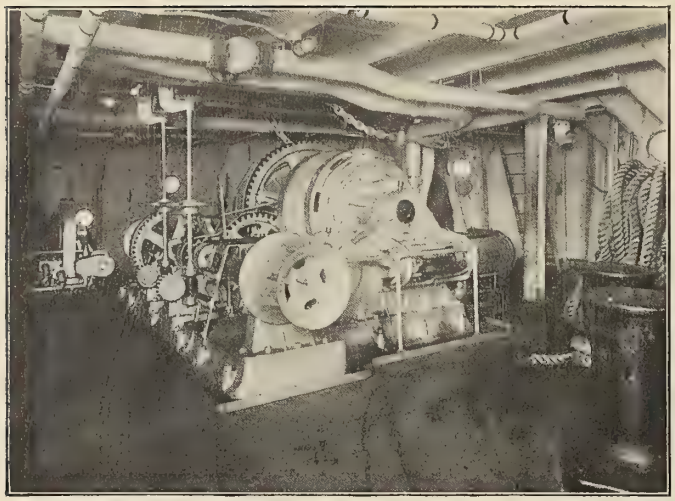


FIG. 5.—WINDLASS ROOM

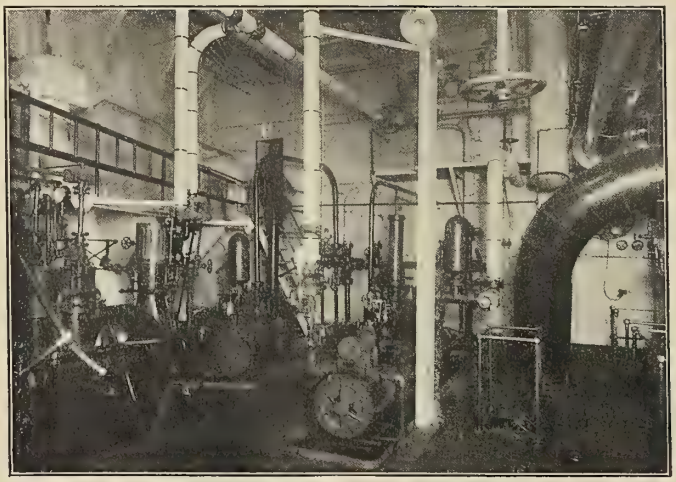


FIG. 7.—PORT SIDE OF ENGINE ROOM AT WORKING DECK, SHOWING MAIN FEED AND FIRE PUMPS AND REFRIGERATING MACHINERY

The outboard shaft is 13½ inches diameter, enlarged at the stern bearing to 15 inches. This bearing is 4 feet 6 inches long, lined with lignum vitæ.

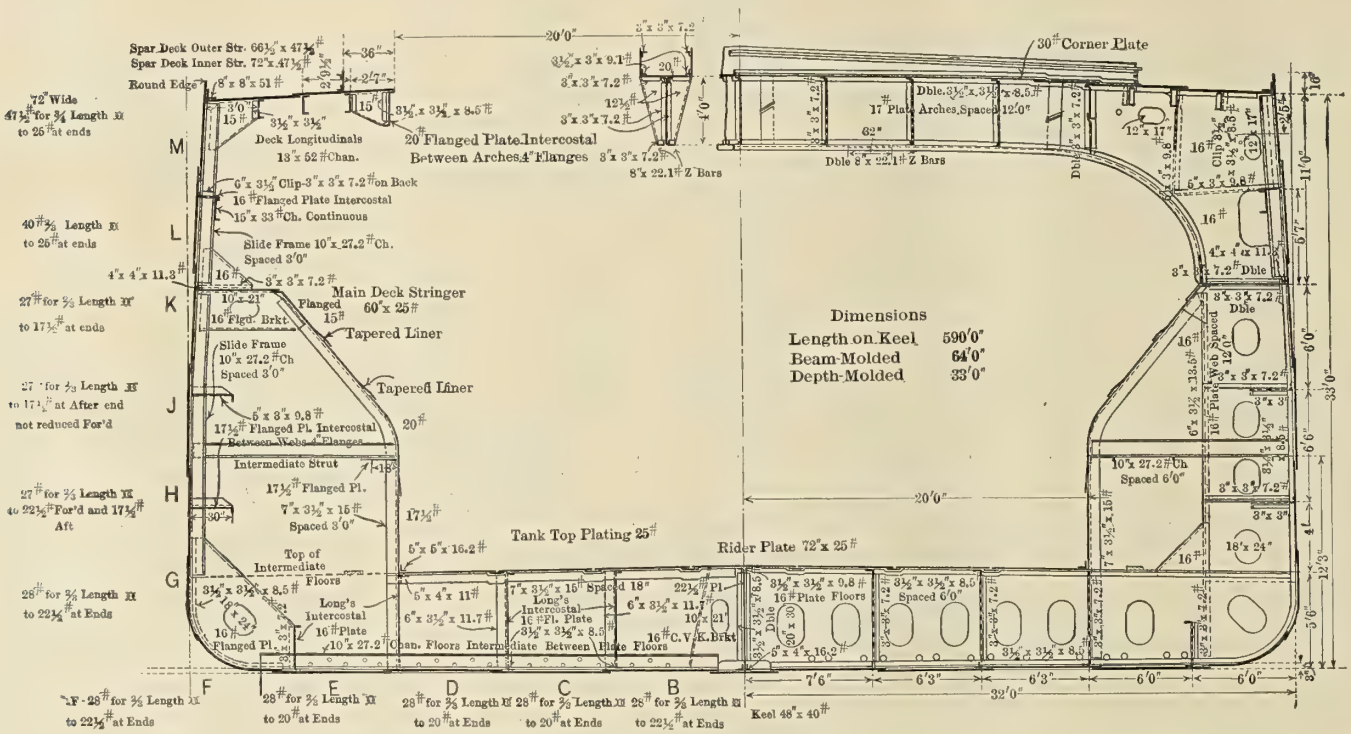
The propeller is of the sectional type, built of semi-steel, 15 feet 9 inches diameter, with a pitch of 13 feet 9 inches and a developed area of 91 square feet.

AUXILIARIES

To handle the immense water ballast capacity of the ships two 18-inch centrifugal pumps are provided, direct connected to two 12-inch by 10-inch enclosed double engines, and two 10-inch by 14-inch by 16-inch reciprocating pumps are located in the lower engine room, conveniently connected to the ballast header and so arranged as to pump in and out of the side tanks and double bottom.

These pumps are connected to each compartment by separate suction and filling pipes 9 inches diameter. Stuffing-boxes are provided where these pipes pass through watertight bulkheads. With this arrangement the different compartments can be filled or emptied singly or all together by either or both pumps. One valve is put in each ballast pump suction at the end of a manifold. Two filling valves, 18 inches in diameter, are located below the light waterline and the pumps discharge overboard above the main deck. There are provided one 8-inch seacock in the fore peak, two 6-inch valves between the fore peak and the forward compartment of the double bottom on each side of the center keelson, and two 6-inch valves between the fore peak and the forward compartment of the hold; two 6-inch suctions are provided from the aft hold to the manifold, with valves and padlocks for locking. The suction ends of ballast pipes are led close to the center keelson on each side, and brass plugs are fitted on all drain and ballast piping at the after end.

The main air pump is driven from the low-pressure crosshead. It is double acting and has a diameter of 30 inches and a stroke of 14 inches. The condenser is of the jet type, 36 inches in diameter by 6 feet 3 inches long. A double-turning engine is provided for the main engine, which is 4½ inches by


Dimensions
Length on Keel 590'0"
Beam-Molded 64'0"
Depth-Molded 33'0"
Tank Top Plating 25#
Rider Plate 72"x 25#
Keel 48"x 40#
Main Deck Stringer
Tapered Liner
Deck Longitudinals
Intermediate Strut
Top of Intermediate Floors
Long's Intermediate
Floors
Frames
Beams
Shell
Inner Bottom
Bilge
Keelson
Stringer Plate
Deck Plating
Deck Beams
Bulkheads
Tunnel
Stringer Angle
Bilge Keel
Bilge Strake
Bilge Diagonal
Bilge Diagonal Strut
Bilge Diagonal Tie
Bilge Diagonal Tie Strut
Bilge Diagonal Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut
Bilge Diagonal Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie Strut Tie
Bilge Diagonal Tie Strut

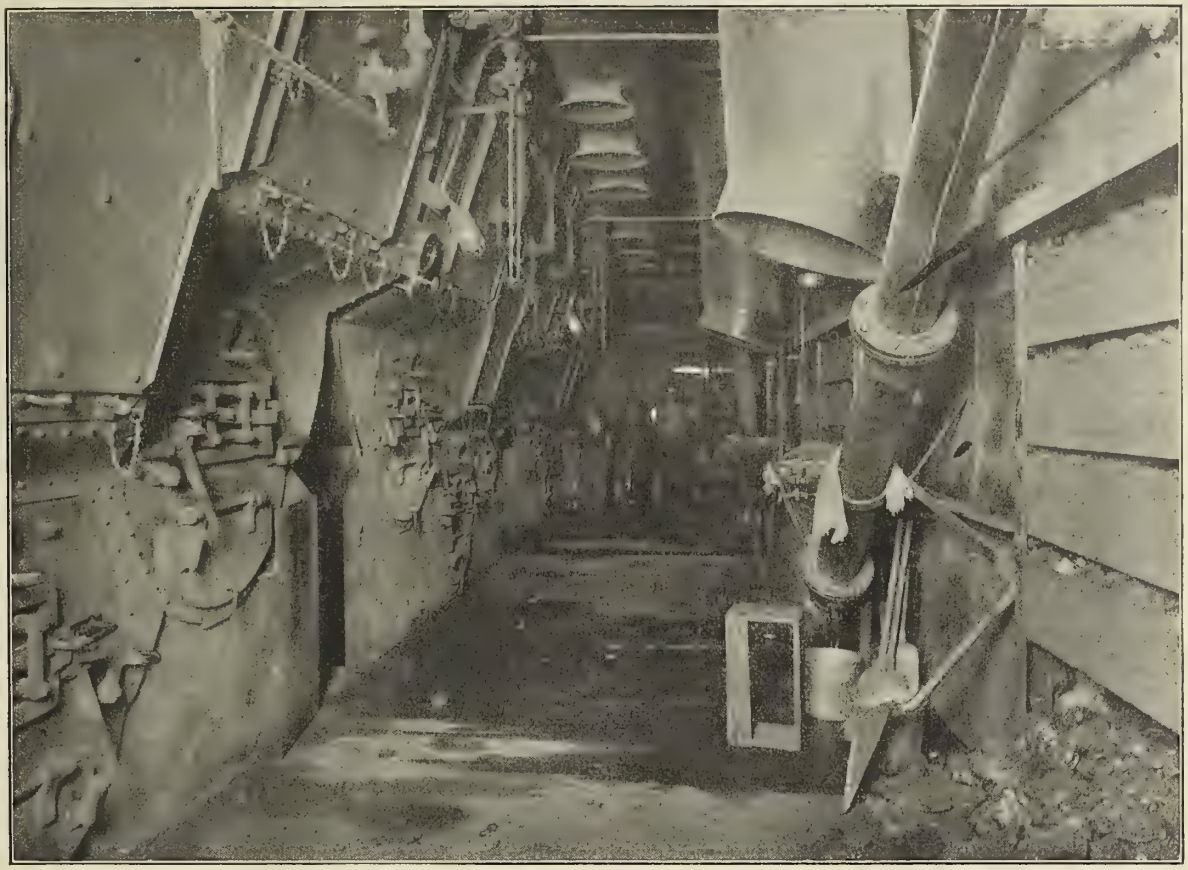


FIG. 8.—FIRE ROOM

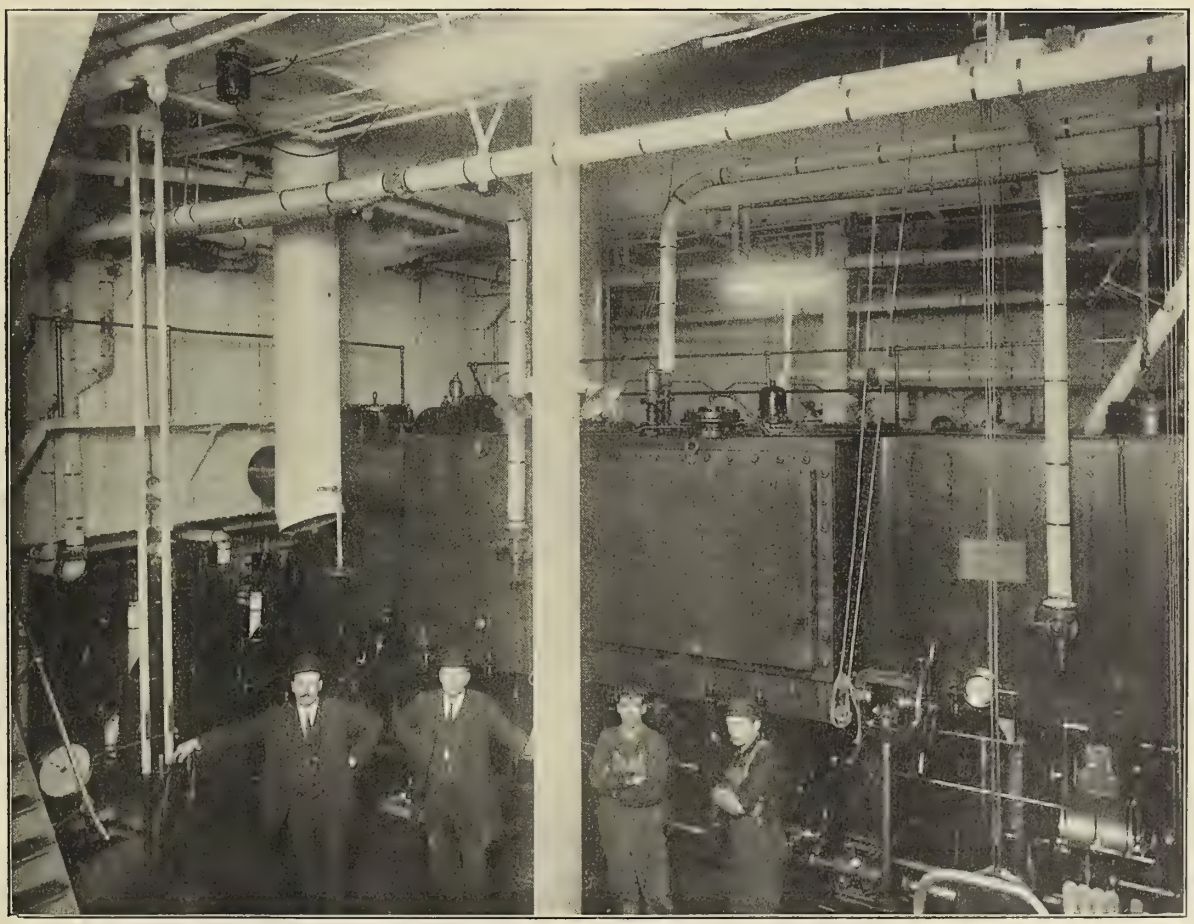


FIG. 9.—STARBOARD SIDE OF ENGINE ROOM AT WORKING DECK

FIG. 10.—GUEST'S STATEROOM

FIG. 12.—CAPTAIN'S QUARTERS, LOOKING TO PORT

6 inches. A direct-connected reverse cylinder, 10 inches diameter by 24 inches stroke, is also installed.

The first item of interest in the deck machinery is the steering gear, which in these ships is a type which represents the latest development of the Great Lakes Engineering Works in this direction. The steering gear is in duplicate, with two wheel stands in the pilot house forward, with transmission gear on each side of the steamer, leading aft to two 9-inch by 9-inch steering engines located on the fantail and connected direct to a cast steel quadrant on the rudder stock.

To handle the mooring cables six engines are installed—four on deck, one aft the cabin and one in the windlass room forward. The deck engines also handle the telescopic hatch covers. There is one windlass aft on the fantail for handling a 3,500-pound anchor and one windlass forward for handling two 4,000-pound anchors.

The engine auxiliaries include a feed pump, 14 inches by 8½ inches by 18 inches; a fire pump, 12 inches by 6 inches by 12 inches, and two duplex pumps, 6 inches by 4 inches by 4 inches, for sanitary purposes. The sanitary system of the steamers is claimed to be the most complete on the Lakes, the tanks for this purpose holding 50 tons of water. A Sirocco fan, 48 inches diameter, driven by a 7-inch by 7-inch type A engine, is fitted for positive-heated forced draft. The electric lighting plant consists of two 15-kilowatt Crocker-Wheeler generators, driven by a 7-inch by 7-inch type A B C engine, and one 10-kilowatt generator of the same make driven by a 6-inch by 6-inch type A B C engine. The feed-water is heated by a Schutte & Köerting special No. 9 feed-water heater, and a Macomb strainer is installed.

FIG. 11.—OBSERVATION ROOM

There does not appear to be any auxiliary apparatus lacking in these ships which would tend to insure safety and convenience in operation. For instance, there is an electric helm indicator in the wheel house, operated by a rheostat connected to the rudder stock, showing the officer in charge the position of the rudder at all times. There is also a simple little device, which is an indicator showing whether the engine is going ahead or astern. This apparatus is installed in addition

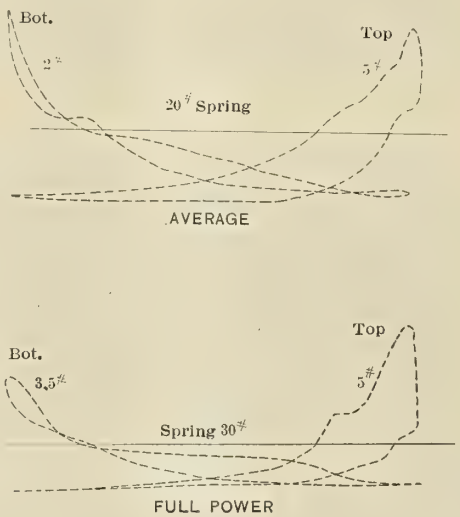


FIG. 13.—AIR-PUMP CARDS

to the usual engine telegraph of the Great Lakes type. There is an electric whistle device to sound signals as they are required as well as to time them automatically during fogs. There is also an emergency alarm, which can be sounded from the pilot house in all departments of the vessel. The telephone service consists of independent lines from the pilot house to the engine room and from the captain's and passengers' quarters to the galley. In the captain's quarters there is a recording compass providing an infallible record of everything that occurs in the wheel house at all hours. A powerful wireless telegraph outfit has been installed. Altogether these ships would appear to have on board every device that human ingenuity has provided to insure safe navigation.

Passenger Accommodations

As stated at the beginning of this article these vessels are bulk freight steamers and are not passenger boats, although luxurious quarters have been provided for a limited number

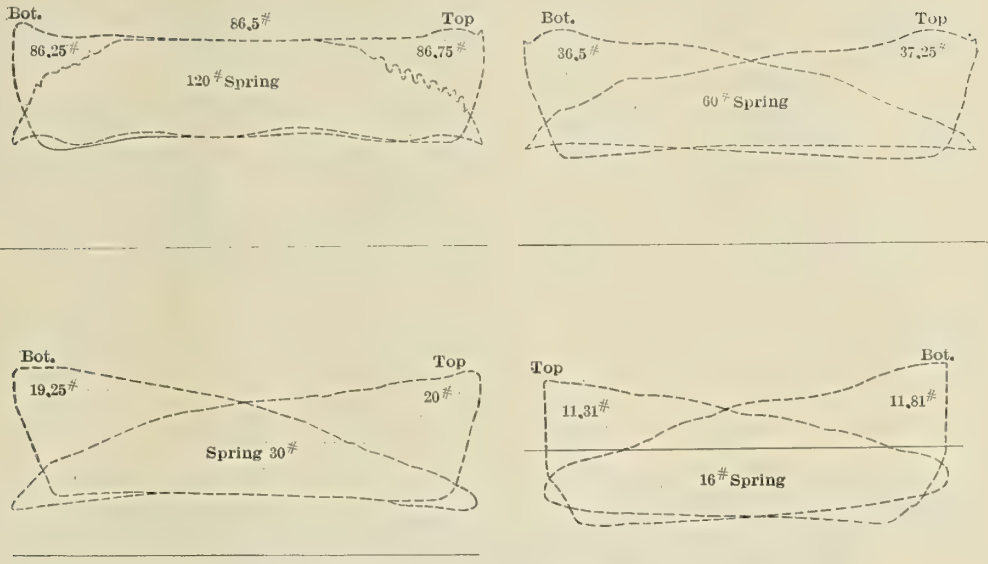


FIG. 14.—SET OF INDICATOR CARDS TAKEN ON LAKE SUPERIOR TRIAL, NOVEMBER 9

of guests. These quarters are unique and distinctive. The entire deck house forward is given over to them.

On the spar deck the deck house is divided by a wide corridor leading directly into a grill room, which extends the full width of the ship. The effect as one enters this hall is quite impressive, as it is produced not only from the appointments of the hall itself, with its ceiling lights and furnishings of fumed oak and Spanish leather, but from the vista it gives of the grill room with its tiled flooring, tiled mantle and electric fireplace.

The quarters for the captain and his guests occupy the space on both the starboard and port sides of this hall. They consist of eight rooms, singly and *en suite*, all finished in white enamel, the furniture being of mahogany with the exception of the beds, which are of brass. Each stateroom is provided with a private bath and shower.

The grill room itself, which is forward of the main hall and staterooms, presents a pleasing effect, with its dull red tile and fumed oak furnishings. The sideboard and china closets are built of fumed oak, with tables and chairs to match. As this room is located as far forward on the spar deck as possible, it is lighted by a dome skylight, which pierces the forecastle deck.

A stairway leads from the corridor on the spar deck to a small hall on the forecastle deck, from which the observation room is approached. In keeping with the general scheme of decoration the observation room is finished in fumed oak with Spanish leather, and is equipped with writing tables, chairs and a built-in settee of splendid proportions, amidships, on the after side of the room. A feature of this room is a Victrola, finished in wood to harmonize with the furniture.

The owner's quarters are on the port side of the forecastle deck immediately aft of the observation room. These quarters consist of one bedroom and a bath room. The captain's quarters are on the starboard side aft of the observation room. A stairway leads from the captain's room to the smoking room or lounge, which is superimposed upon the observation room. This might be called the passengers' pilot house, as it occupies the space usually employed by the pilot house on a freighter. Superimposed on the lounge is the enclosed pilot house.

The cooking for the grill room forward is by electricity,

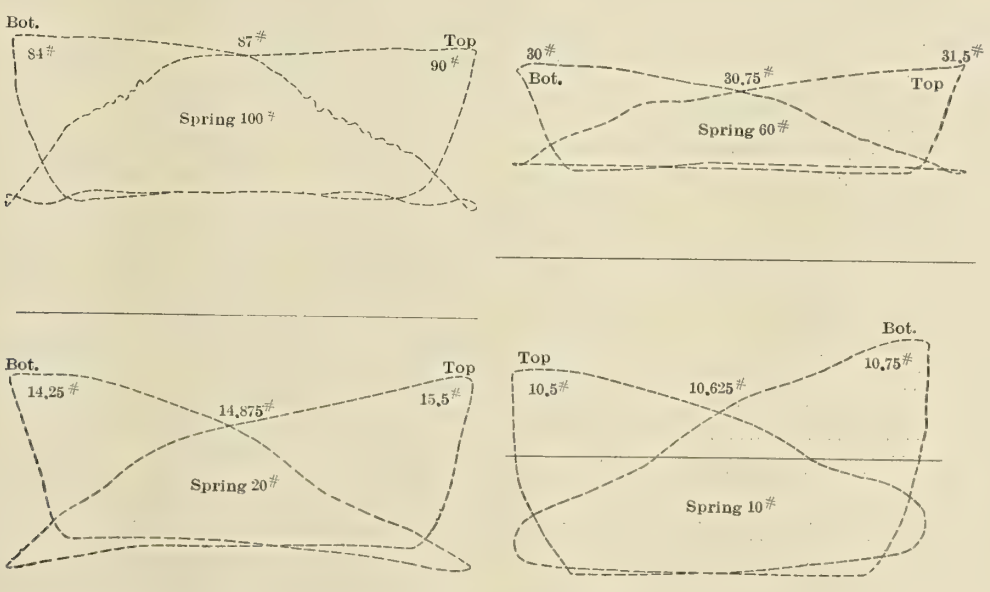


FIG. 15.—SET OF INDICATOR CARDS TAKEN ON LAKE HURON TRIAL, NOVEMBER 8

the galley being on the main deck beneath the passenger quarters, the service being accomplished by a dumbwaiter. An electric stove and steam tables are installed in the galley, while the stores are protected by refrigeration, the ice machine, built by the Phœnix Ice Machine Company, being located in the dunnage room immediately forward of the galley. In this refrigerating system coils of extra strong pipe are placed in the boxes, and liquid anhydrous ammonia is evaporated within them at a very low temperature. In evaporating the ammonia takes up the heat. Brine tanks of ample capacity are provided to maintain an equality of temperature when the plant is not running. This system also provides for making ice for table use in suitable-sized molds.

The dunnage room on these ships will be "a thing of joy" to an orderly mate, as it is quite different from the old-style, inconvenient and disorderly dunnage room found on the majority of freight steamers. The dunnage room extends the full width of the ship, is spacious, light and airy, with a place for everything, and it can easily be observed that everything is in its place.

Great care was taken in the design of the crew's quarters. The first and second mate are housed on the forecastle deck directly aft of the owner's quarters. These rooms are provided with a shower. The forward crew is housed on the main deck directly underneath the passenger quarters, and these accommodations are supplied with all modern conveniences. The after crew, including the deck hands, have ample quarters on the spar deck aft, the rooms being located around the engine room casing. Shower baths are provided in each department with private baths for the chief and first and second engineers. All rooms on the boat are provided with an electric fan, and a drying room is also provided aft of the boilers.

The after end of the deck house is given over to the private dining room for the guests. The crew's dining room is also located on this deck, the private dining room being on the starboard side and the crew's dining room on the port side.

A complete outfit of lifeboats and rafts ample for the full number of crew and passengers is installed.

TRIALS

A series of trials was carried out on board the *Col. James M. Schoonmaker* by Messrs. Turnbull, Oftedahl and Cameron. The trial trip consisted of a run on Nov. 8 and 9 on Lake Huron, between Thunder Bay Isle and Detour. At the time of the trials the vessel was loaded to a draft of 16 feet 8 inches forward and 17 feet aft. The load was 10,600 tons net, 9,464 tons gross; fuel, 400 tons at Ashtabula. The data from these tests are as follows:

DURATION OF TEST, 2 P. M. TO 8 P. M.; COAL WEIGHED. FROM 2:01 TO 8:10 P. M., IND. CARDS EVERY HOUR.

Boiler pressure, pounds per square inch	207.7
I. P.[1] receiver, pounds per square inch	95.3
I. P.[2] receiver, pounds per square inch	38.9
L. P. receiver, pounds per square inch	7.88
Vacuum, inches	21.78
Revolutions per minute, average 6 hours	81.5
Piston speed, feet per minute	570.5
M. E. P., H. P. cyl., pounds per square inch	86.1
M. E. P., I. P.[1] cyl., pounds per square inch	29.57
M. E. P., I. P.[2] cyl., pounds per square inch	14.96
M. E. P., L. P. cyl., pounds per square inch	10.75
Ref. M. E. P. to L. P., pounds per square inch	34.21
I. H. P., H. P. cyl	605
I. H. P., I. P.[1] cyl	443.9
I. H. P., I. P.[2] cyl	468.0
I. H. P., L. P. cyl	694.9
I. H. P., total	2,211.8
I. H. P. to grate surface	13.40
Heating surface to I. H. P	3.52
Temp. of inj. water, degrees Fahr	47.1
Temp. of hot well, degrees Fahr	135.1
Temp. of feed-water, degrees Fahr	192.0
Temp. of stack, degrees Fahr	313.0
Temp. of air casing, degrees Fahr.:	
Port	234.0
Center	247.0
Starboard	231.0
Temp. of ash-pit, degrees Fahr.:	
Port	256.0
Center	262.0
Starboard	276.0
Temp. of fan intake, degrees Fahr	84.0
Temp. of engine room, degrees Fahr	88.0
Draft at fan, inches	1.57
Draft in ash pits, inches:	
Port	.40
Center	.40
Starboard	.35
Draft in air casing, inches:	
Port	.8
Center	.8
Starboard	.85
Draft in smoke-box, inches	—.26
Revolutions of fan	337
Coal, half slack, ran on grates clinkered.	
Coal, total 6 hours, 9 minutes, pounds	22,595
Coal per hour, pounds	3,674
Coal per hour per I. H. P., pounds	1.66
Coal per hour per square-foot grate, pounds	22.20
Combustible, total 6 hours, pounds	18,754
Combustible per hour, pounds	3,125
Combustible per hour per I. H. P., pounds	1.41
Ash total, pounds	3,920
Ash, percent	15
Speed of ship, miles per hour	12
From Thunder Bay Island to Detour, 73 miles	6 hours 5 minutes
Slip, percent	5.76
$\frac{\text{I. H. P.} \times 33{,}000}{P \times R}$	65,138
$C = \frac{D^{2/3} \times S^3}{\text{I. H. P.}}$	311.5

Cuts—
H. P. 2¾ inches, I. P.[1] 1½ inches, I. P.[2] 1½ inches,, L. P. 1¾ inches.
Weather—Cloudy, light head wind; no sea.
Average flue-gas analysis, "CO_2" 8.4, "CO" 0, "O" 10.2.

FULL POWER TRIAL ON LAKE SUPERIOR, NOVEMBER 9

Boiler pressure, pounds per square inch	204
I. P.[1] receiver, pounds per square inch	111
I. P.[2] receiver, pounds per square inch	48
L. P. receiver, pounds per square inch	10.4
Vacuum, inches	21¼
Revolutions per minute	90.5
Piston speed, feet per minute	633.5
Ref. M. E. P. to L. P	39.31
Cuts	All off.
M. E. P., H. P. cyl., pounds per square inch	86.5
" I. P.[1] cyl., pounds per square inch	36.88
" I. P.[2] cyl., pounds per square inch	19.62
" L. P. cyl., pounds per square inch	11.81
I. H. P., H. P. cyl.	675
" I. P.[1]	614.6
" I. P.[2]	634.8
" L. P.	847.7
" Total	2,822.1

Note.—Readings are average for one hour.

TRIAL RUN ON LAKE HURON, NOVEMBER 8

Boiler pressure, pounds per square inch	208
I. P.[1] receiver, pounds per square inch	95
I. P.[2] receiver, pounds per square inch	38
L. P. receiver, pounds per square inch	8
Vacuum, inches	21.75
Revolutions per minute	81.5
Piston speed, feet per minute	570.5
Ref. M. E. P. to L. P	34.48
Cuts—	
H. P. 2¾ inches, I. P.[1] 1½ inches, I. P.[2] 1½ inches, L. P. 1¾ inches.	
M. E. P., H.P. cyl., pounds per square inch	87
" I. P.[1] cyl., pounds per square inch	30.75
" I. P.[2] cyl., pounds per square inch	14.87
" L. P. cyl., pounds per square inch	10.63
I. H. P., H. P. cyl.	611.4
" I. P.[1] cyl.	461.9
" I. P.[2] cyl.	465.3
" L. P. cyl.	687.5
" Total	2,226.1

DATA FOR AIR-PUMP CARDS, NOVEMBER 8 AND 9

	Average.	Full Power.
M. E. P., pounds per square inch	3.5	4.25
Revolutions per minute	81.5	90.5
Piston speed, feet per minute	190	211
Vacuum, inches	21.5	21
I. H. P.	14.2	19.2

Henry Bell's steamboat *Comet,* which was the first passenger steamboat built in Great Britain, was launched from the shipyard of John & Charles Wood at Port Glasgow on July 24, 1812. The centenary of this historical event has therefore been fittingly observed on the corresponding date this year. The boat was laid down in October, 1811, and completed her trial trip from Greenock to Glasgow on Aug. 6, 1812. Subsequently she maintained a regular service on this and other routes until on Dec. 15, 1820, she was destroyed by the wind and tide on the rocks off Craignish Point on the west coast of Argyllshire.

A New Type of Transport Ship for Submarines

During the last few years the well-known firm of Messrs. Schneider & Co., Creusot, France, has secured a number of important orders for submarine boats for foreign navies. These boats have been built under the direction of Mr. Laubaeuf, whose design of submersible vessels is well known. It has been found somewhat difficult, however, to ship these submarines to very distant countries, as, for instance, to Peru, and, therefore, Messrs. Schneider & Co. placed an order at the Gironde Works, Bordeaux, for the construction of a peculiar type of vessel designed as a transport ship for carrying submarines on long sea voyages. This boat, which is named the *Kangaroo,* has recently been launched. Her principal dimensions are:

LAUNCH OF THE KANGAROO

Length between perpendiculars	305 feet 2 inches
Beam	39 feet 4 inches
Depth	23 feet 10 inches
Draft, loaded	19 feet 7 inches
Displacement at above draft	5,540 tons
Capacity of hold	117,000 cubic feet
Deadweight capacity	3,830 tons

The vessel is built of mild steel under a special survey by the Bureau Veritas. Her propelling machinery consists of a triple-expansion engine of 850 indicated horsepower, designed to give the ship a speed of 10 knots. The engine has been built by the Dyle & Bacalan Works, Bordeaux.

The design of the hull involves some unusual features in order to obtain a main hold 193 feet 7 inches long, extending nearly the whole width of the ship, for the accommodation of submarines. A double bottom has been worked from end to end of the ship, together with longitudinal wing ballast tanks, which are so designed as to give the ship practically the characteristics of a floating dry dock. The forward part of the ship may be connected or disconnected at will, so that the submarine can be floated directly into the main hold, inside of which it can be berthed as in a floating dry dock. When the submersible is placed in the hold, water is pumped out of the ballast tanks, causing the vessel to rise until the submarine craft is lifted out of the water, resting in a special cradle fitted inside the main hold. The forward part of the ship is then connected and the vessel becomes an ordinary cargo boat.

Owing to the arrangement of the water ballast tanks the ship may be placed at the required trim, first for the opening of the forward part of the ship, then to permit the submarine to float inside, and finally for the closing of the opening in the forward part of the ship. Aft of the main hold are the bunkers, the main and auxiliary machinery and accommodations for the officers and crew. Special accommodations are also provided for the officers and crew of the submarine, all living quarters being heated by steam and lighted by electricity.

As announced in our November, 1911, issue, James Rees & Sons Company, Pittsburg, Pa., have had under construction fourteen light-draft steamers for use on the Amazon River. Seven of these boats were shipped before May 1, and the remaining seven have just been completed, making an average of one vessel every thirty days. These steamers are 125 feet long on the deck, 26 feet beam, 3½ feet depth of hold, with engines 9 inches diameter by 4 feet stroke, furnished with steam from a locomotive type boiler. The wheel shafts for nine of these boats were made from heat-treated type A chrome Vanadium steel, by the Erie Forge Company, Erie, Pa. They are 5½ inches hexagonal and 22 feet long, with journals 5¾ inches long and 5½ inches diameter. Tests from these shafts show the following physical qualities: Elastic limit, 109,900 pounds; tensile strength, 143,400 pounds; elongation in 2 inches, 17 percent; reduction of area, 53.3 percent. A test piece, ½ inch thick by 1 inch wide, cut from the shaft, was bent over on itself cold. The electric generators for these boats were furnished by the Westinghouse Electric & Manufacturing Company, Pittsburg, the generators being directly connected to 6 by 5-inch vertical self-oiling steam engines, supplied by the American Blower Company, Detroit.

Automatic Acetylene Lights for the Panama Canal

Among the numerous interesting features connected with the Panama Canal will be found a most ingenious lighting arrangement which will make night navigation through the canal as safe as in broad daylight. At the entrances and through Gatun Lake, as shown on the accompanying map, a double row of about sixty automatic-lighted buoys will mark the channel. The contract for furnishing this lighting equipment has been awarded by the Isthmian Canal Commission to the American Gasaccumulator Company, of Philadelphia, Pa., manufacturers of the AGA automatic aids to navigation.

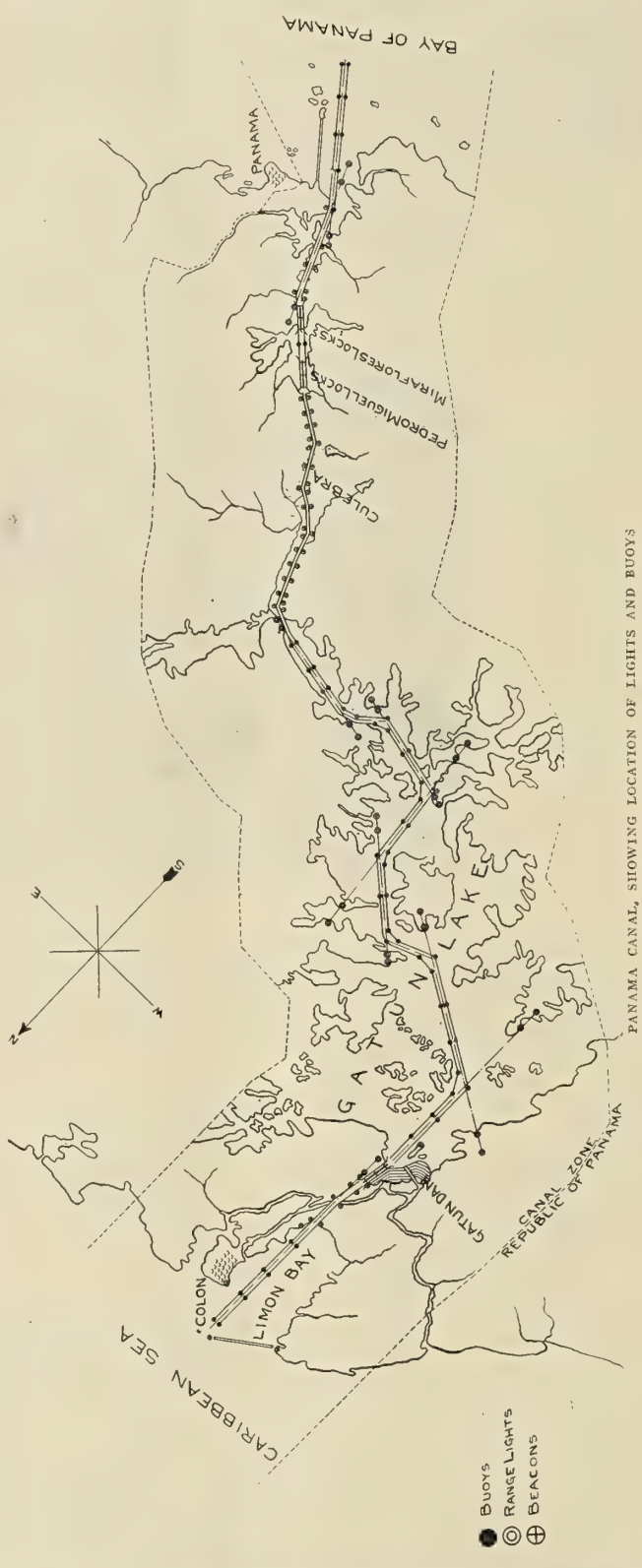
The buoys have been designed to meet the special requirements of the Isthmian Canal Commission, and all are equipped with AGA lanterns, having an optical range of about 12 miles. Each light will have its distinguishing characteristic, and for this purpose the lanterns will be equipped with AGA flashers, some producing single, others complex flashes. Colored lights, with their tremendous disadvantage in reducing the range of visability, will be entirely avoided.

With reference to the range lights two AGA installations have already been established at the Pacific entrance. These produce a very powerful light, having an optical range of more than 20 miles. They are equipped with flashers, but the flashes occur so rapidly that the impression of the light is continuously retained on the eye, so that the navigator can lead up to the range with the same ease as he would to fixed lights, and he has the additional security of a distinctive light character impossible of being confused with shore or ship's lights.

The AGA sun valve is also employed, which performs the functions of a keeper in extinguishing the lights at sunrise and lighting them again at the approach of darkness. The AGA sun valve is actuated entirely by light, and is not affected by temperature changes. The construction of the sun valve is based upon the well-known physical law "that absorbed light is transformed into heat." It consists of four metal rods enclosed within a stout glass cylinder. The central rod is coated with lampblack, which gives it the property of absorbing light, while the three rods surrounding it are polished and light reflecting. All of these rods expand in the same degree with the application of heat, but the inner one only responds to light, the additional expansion caused thereby being employed to actuate a valve which controls the passage of gas to the main burner. During daylight the black rod has expanded and closed the valve, at the approach of darkness it contracts and the valve opens. A continuously-burning pilot flame attached to the main burner and fed directly from the gas supply ignites the gas.

The illuminating medium of the AGA system, acetylene, is stored in large quantities in small portable steel cylinders. This is made possible by the use of what is known as "dissolved acetylene." The dissolving agent is acetone, a liquid which possesses the quality of absorbing or dissolving about twenty-five times its own volume of acetylene for each atmosphere of pressure at 60 degrees F. To prevent any possibility of explosion the cylinder, or accumulator, as it is called, is first filled with a highly porous mass of special composition, which is introduced in a pasty form and baked to hardness. The porous mass has the effect of segregating the particles of acetylene, so that an explosion wave cannot spread through the cylinder. The acetone is then forced into the accumulator until it occupies about 40 percent of the interior volume. The accumulator is then charged with pure, dry acetylene and is ready for service.

The AGA installation with four of these small accumulators of dissolved acetylene, it is claimed, will operate uninterruptedly and without attention for a year or more. The flasher, while providing a distinctive light characteristic, also effects an enormous saving of gas, due to the dark periods when gas is not being burned; ordinarily about one-tenth of the gas is consumed that would be required for a continuous light. But the final word in gas economy is attained by the sun valve, which permits the gas supply to be used only during darkness, and effects, it is claimed, an additional saving of about 40 percent.



PANAMA CANAL, SHOWING LOCATION OF LIGHTS AND BUOYS

Liquid Fuel Measurement on Oil-Burning Steamships—II

BY HOWARD C. TOWLE

Having stated the manner by which the vessel's engineers can obtain accurate measurements, there still remains the other requirement for accurate results—that the measuring tank capacity be exactly obtained and recorded in such a way that this object will be obtained by simple means.

The capacity of the tank can be obtained by "water gaging" or by the ordinary methods of calculation from measured offsets. Although the first method would appear to be the most reliable, actual experience has proven that unless very carefully done, this method does not give such reliable results as careful calculation, when the possible sources of error in the latter method are avoided. There are four principal sources from which errors arise, namely, framing and other obstructions in the tank, pockets in which air may become confined, the trim of the vessel, and the list of the ship when the sounding tube is not at the center of gravity of the free surface of the liquid in the tank.

Framing and other obstructions in the tank should be allowed for by direct calculation of the capacity to be deducted, and not by a percentage allowance of the total capacity, for the deduction not only varies in different tanks, but also is usually variable in percentage for the whole depth of the tank.

Confined air is only avoided by the provision of means for its ready and continuous escape from all pockets and from the highest point or points of the tank. All air-escape pipes should be fitted so as to positively exclude all water while providing means for the rapid intake or expulsion of air. Recent practice is to make the air-pipes about one-half the area of the filling pipe or the suction pipe, as the speed of the air through the pipe can safely be made considerably higher than that of the oil when the tank is being filled or pumped out.

The trim of the vessel is a constantly varying quantity, and must always be taken into consideration except in the ideal case in which the ullage can always be measured at the center of gravity of the free surface of the oil in the tank. In practice, it is seldom that it is possible or convenient to take the ullage measurements in the ideal way, and therefore it becomes necessary to obtain a method of readily correcting for trim if accurate results are to be obtained. A separate calculation of the amount of correction could be made, in the same manner as the usual correction for trim is made in calculating the displacement of vessels. The additional mathematical work is not desirable because of the increased chance of error involved, therefore the following method of making the capacity scales is suggested.

Let the shaded portion in Fig. 3 represent a tank of fuel oil located in a steamer.

Measure the distance A between the draft marks at the bow and the stern, or between the draft gages if they are fitted. Find the center of gravity of the free surface of the liquid at different ullages, u', u'', u''', etc., and the distances of these centers of gravity from the sounding tube, d, d', d'', d'''. Also obtain accurately the net capacities at the various ullages, by the usual methods.

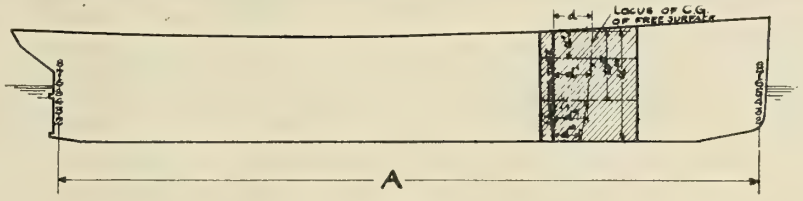


FIG. 3

Construct a diagram as shown in Fig. 4 in the following manner: On any convenient base line, B-B', erect the perpendiculars C-F, D-G, and E-H, so that the distance C-D equals D-E. Divide C-F and D-G into divisions corresponding to the draft of the vessel, but making the scale of D-G one-half the scale of C-F. If the sounding tube is aft of the center of gravity of the free surfaces mark the scale C-F "Forward" and the scale D-G "Aft," but if the sounding tube is forward of the centers of gravity then mark the scale C-F "Aft" and the scale D-G "Forward."

At any convenient point on the base line B-B' as u erect a perpendicular u-u''' and make the distance u-u''' equal to the total depth of the tank on any suitable scale that bears a definite ratio to the draft scale C-F, and divide the distance to read ullages from the line at u to the point u'''.

Take points on the scale u-u''' as u', u'', u''', so that the distances uu', uu'', uu''', are equal to the ullages u', u'', u''', in Fig. 3 to scale, and draw lines from these points to the point E.

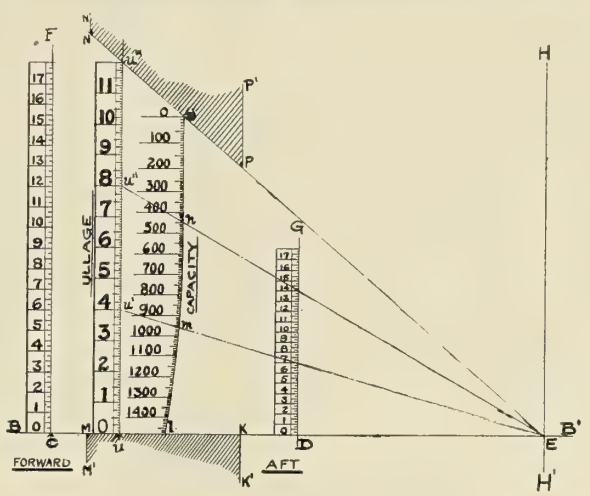


FIG. 4

Divide the distances Eu, Eu', Eu'', Eu''', at m, n, o, so that the distances

$$\frac{mu'}{mE} = \frac{d' \times \text{scale of } u\text{-}u'''}{A \times \text{scale of } C\text{-}F}$$

and

$$\frac{nu''}{nE} = \frac{d'' \times \text{scale of } u\text{-}u'''}{A \times \text{scale of } C\text{-}F}$$

and

$$\frac{ou'''}{oE} = \frac{d''' \times \text{scale of } I\text{-}J}{A \times \text{scale of } C\text{-}F}$$

and

$$\frac{lu}{lE} = \frac{d \times \text{scale of } u\text{-}u'''}{A \times \text{scale of } C\text{-}F}.$$

Draw a curve, *l, m, n, o,* through the spots so obtained, mark the capacity at each ullage depth along *l, m, n, o,* and subdivide for the intermediate capacities. The spot for zero capacity is evidently on a line from *E* to the total depth spot *u‴*, and the spot for the total capacity is at *u* on the base line *B-B'*.

The method of using the scale is as follows: After the draft forward and aft, and the ullage are measured, the drafts forward and aft are laid off on their respective scales, *C-F* and *D-G* and a straight-edge laid across the two points. The point of intersection of the straight-edge and the line *H-H'* is marked. Then the straight-edge is shifted so that it goes through the spot on *H-H'* just obtained and also through the point on *u-u‴* corresponding to the measured ullage of the liquid in the tank. The capacity indicated by the intersection of the straight-edge on the line *l, m, n, o,* is the capacity corrected for trim, provided that the level of the liquid in the

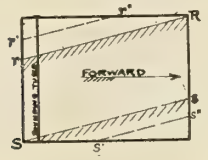


FIG. 5

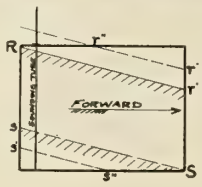


FIG. 6

tank is not above the upper corner of the tank (*R* in Figs. 5 or 6) or is not below the lower corner of the tank (*S* in Figs. 5 or 6).

In practice no engineer would work so little margin of fuel as the lower level represented, and the tank should never be completely filled, in order to allow room for possible expansion due to changes in temperature, so for all practical purposes the diagram without the limiting areas shown in Fig. 4 will be sufficient. If desired, however, a limiting ullage for any trim can be obtained as follows: In Fig. 4, divide the distance *u-E* at the point *K* so that

$$\frac{u\text{-}K}{K\text{-}E} = \frac{\text{Distance from the tube to upper forward end}}{\text{Length between draft marks } (A) \text{ of the tank} \times \text{scale of } u\text{-}u''' \times \text{the scale of } C\text{-}F}.$$

erect a perpendicular at the point *K* as *K-K'* and shade the area *u-K-K'*, the shaded portion represents the incorrect zone at the top of the tank when the vessel is by the head. Also make

$$\frac{u\text{-}M}{u\text{-}E} = \frac{\text{Distance from tube to upper after end}}{\text{Length between draft marks } (A) \text{ of tank} \times \text{scale of } u\text{-}u''' \times \text{scale of } C\text{-}F}.$$

Erect the perpendicular *M-M'* and shade the area *u-M-M'*. Then the shaded area represents the incorrect zone at the top of the tank when the vessel is by the stern. Divide the line *u‴-E* at the points *P* and *N* in the same ratio, but using the distances from the sounding tube at the bottom of the tank. Draw *P-P'* and *N-N'* perpendicular to the base, and shade the area *N N' PP'*, the shaded area representing the incorrect zone at the bottom of the tank.

Now, in using the straight-edge for reading capacities, when the edge is laid across the diagram from the ullage point on *u-u‴* to the trim spot on *H-H'*, if it is found that the straight-edge bisects the shaded portion of the figure, it will be known that the liquid in the tank comes above the upper corner of the tank or below the lower corner, as the case may be (*R* or *S* in Figs. 5 or 6), and that the correct capacity cannot be obtained directly from the diagram. The capacity should then be taken for the ullage intersected when the straight-edge intersects the trim spot on *H-H'* and either of the points *P, K, M,* or *N* and the additional volume *R, r, r', r''*, or volume to be subtracted *S, s, s', s''* (see Figs. 5 and 6) be separately calculated. This can be done for all conditions of trim except when the trim throws the oil in the bottom of the tank entirely clear of the sounding tube, as *S'-s''* in Fig. 5, which case can only be taken care of by additional piping.

For a rectangular tank the added or subtracted capacity can be obtained by the formula:

$$\text{Volume} = X\,(B \times L) - \frac{X^2}{T}\left[\frac{A \times B}{2}\right]$$

Where:

A = The length between the draft marks or gages of the ship;
B = The breadth of the tank;
L = The length of the tank;
T = The trim of the ship;
X = The difference between the measured ullage and the ullage indicated by the straight-edge passing through the trim spot on *H-H'* and the points *K, M* or *P*.

The expressions within the parentheses are constant for any given case and the trim of the vessel and the ullage are the only variables.

It will be noted that to take such a case as is represented by *R, r, r', r''*, in Fig. 6, it would be necessary for the sounding pipe to extend above the top of the tank, and for the ullage scale, *I-J*, to be laid off from the top of the sounding tube, or if laid off from the top of the tank, the distance *X* in the formula, should be made equal to the distance from the ullage intersected on Fig. 4 by the straight-edge to the top of the tank, plus the negative ullage above the top of the tank.

The derivation of this method of measuring capacities can be shown by taking as an example a rectangular tank located

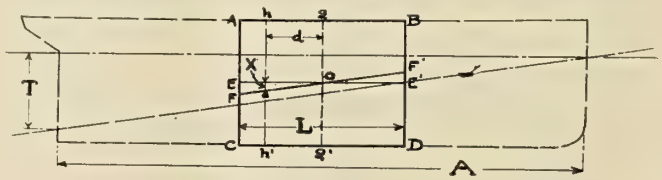


FIG. 7

in a vessel as *A, B, C, D,* in Fig. 7. Let *E-E'* be the surface of the liquid in the tank when the vessel is on an even keel, and *F-F'* the surface when the vessel has been given trim as represented by the distance *T*. (It is evidently immaterial whether the draft changes or not.)

As the surface of the liquid in the tank always remains parallel to the surface of the sea at any trim, it is evident that any change in the ullage, as *X*, shown in the sounding tube *h-h'*, due to a change in the trim of the vessel, will be proportional to the distance *d* and the length between draft marks *A;* or:

$$\frac{\text{Change in ullage } "X"}{\text{Change in trim } "T"} = \frac{d}{A}$$

In a trapezoid the triangles adjacent to the parallel sides are similar, for all corresponding sides are parallel, and, therefore, the corresponding sides are proportional to the bases of the triangles. Thus in Fig. 8 in the trapezoid *K, L, M, N,*

$$\frac{P\text{-}K}{P\text{-}M} = \frac{K\text{-}N}{L\text{-}M}$$

Let Fig. 9 be a capacity diagram laid out in the same manner as that shown in Fig. 4, except that the scale for ullages and

for draft (C'-F') are the same. Let C'-F'' and D'-G'' be the drafts forward and aft, draw the straight line F''-G''-E' and note the intersection M on the capacity line L-O. Now, let the vessel trim the amount T,' and draw the line, E''-M-F', intersecting the ullage line U-U''' at the point U''. Now it is evident that

$$\frac{X'}{T'} = \frac{U'\text{-}M}{M\text{-}E'},$$

as demonstrated by Fig. 8.

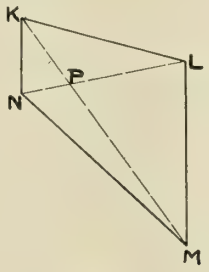


FIG. 8

But when we constructed the diagram we located the capacity line L-O by the proportion,

$$\frac{M\text{-}U'}{M\text{-}E'} = \frac{d}{A}$$

(the scales being the same, the ratio of the scales becomes equal to unity) and, therefore, by combination we have

$$\frac{X'}{T'} = \frac{d}{A},$$

and a line drawn from E'' to the point U'' will give the required reading on the capacity scale L-O for the same capacity with any change in trim.

It will be noted that it is assumed that the ullage-rod is constrained by a tube, or other means, to move parallel to the draft marks at the bow and stern of the vessel. For moderate trim and small ullages the error due to the ullage rod hanging free would be immaterial, but when considerable change in

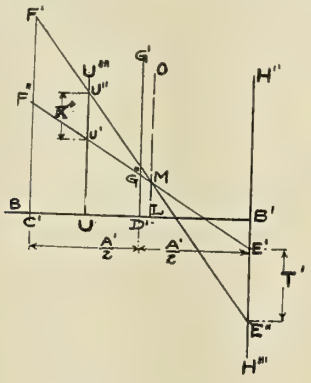


FIG. 9

trim is probable between successive measurements, as in vessels with their machinery aft, a tube should be fitted for accurate results.

Any change in the trim of the vessel evidently does not change the volume of the liquid in any tank in the vessel, and, therefore, in Fig. 7 the triangles, $E\ O\ F$ and $E'\ O\ F'$, must be of equal area. But in a rectangular tank the triangles can only be equal when the point O is at the half-length of the tank; in other words, the center of gravity of the free surface of the liquid. If the sounding pipe was located so as to go through these points for the whole depth of the tank, it is evident that no change in ullage would result from any change in trim.

Errors due to the list of the ship can be correctly allowed for by a similar method to that used for correcting for the trim of the ship. In Fig. 10, let A' B' C' D' represent the transverse section of the tank, which may or may not be symmetrical about its center line. Let g-g' be the calculated locus of the center of gravity of the free surface, h-h' the location of the sounding tube, and let d' be the distance of the tube from the locus, and E-E' any level of the liquid in the tank.

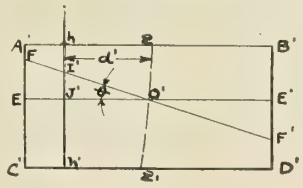


FIG. 10

Let F-F' be the surface of the liquid when the inclination of the vessel is θ degrees, as shown by the vessel's clinometer.

Then it is evident that I'-J' is to $(EF + E'\ F')$ as $O'\ J'$ is to E-E'.

But I'-J' is the change in ullage reading due to the inclination θ, and $(EF + E'\ F')$ is equal to $EE' \times \tan\theta$; therefore (introducing the ratio of the scales used in drawing the diagram, Fig. 11), we obtain the proportion,

$$\frac{\text{Change in ullage}}{\text{Tan } \theta \times \text{breadth of tank}} = \frac{d' \times \text{scale of ullage } (U\text{-}U' \text{ in Fig. 11}).}{\text{Breadth of tank} \times \text{scale of } (N\text{-}N' \text{ in Fig. 11}).}$$

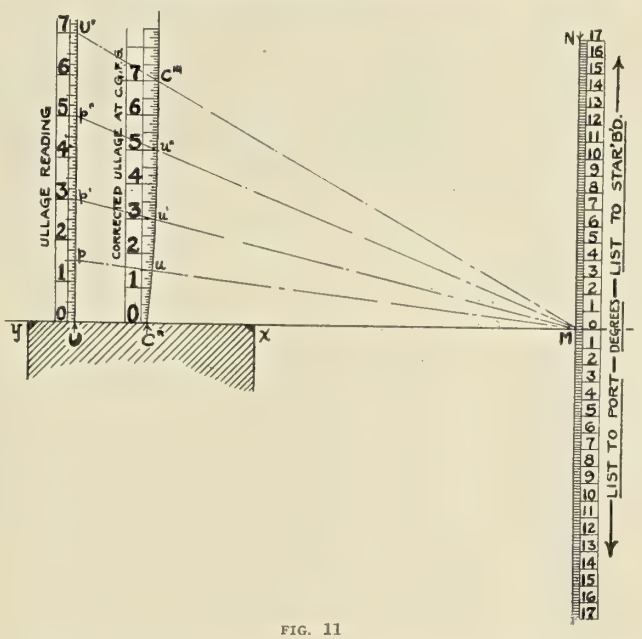


FIG. 11

Using the property of the trapezoid referred to above, construct the diagram shown in Fig. 11 in the following manner:

On the base line U-M erect the perpendiculars U-U' and N-M-N'; divide the line U-U' into equal parts to any definite scale to represent the ullages as read on the vessel, from zero to the full depth of the tank. Lay off on N-M-N' distances above and below the point M, making the distance for each degree of heel equal to tan $\theta \times$ the mean breadth of the tank, to any definite scale. From points on the ullage scale, U-U' as p, p' p'', corresponding to the ullages at which the distances d' in Fig. 10 were calculated, draw lines to the point M as

p-M, p'-M, p''-M, U'-M. Divide these lines at u, u', u'', C''', in the proportion,

$$\frac{p\text{-}u}{u\text{-}M} = \frac{d' \times \text{scale of ullage } (U\text{-}U')}{\text{Breadth of tank} \times \text{scale of tan } \theta \times \text{breadth of tank } (M\text{-}N)}$$

Draw a curve, C'', u, u', u'', C''', through the spots obtained, and subdivide so that a straight-edge passing through the spot M will intersect the same figure for ullage on both the scales, U-U' and C''-C'''.

If the sounding tube is toward the port side from the center of gravity of the free surface of the liquid in the tank, mark the scale M-N "List to port," and the scale M-N' "List to starboard," but if the sounding tube is toward the starboard side from the center of the surface, mark N-M "List to starboard" and M-N' "List to port."

In using the diagram spot off on N-M-N' the list of the ship in the proper direction, and spot off on U-U' the ullage as read from the tank. Lay a straight-edge across the diagram through the two spots and obtain from the scale C''-C'''; the equivalent ullage at the center of the free surface of the liquid in the tank. Use this latter figure for ullage instead of the ullage read from the tank in finding the capacity from the diagram shown in Fig. 4.

Incorrect zones at the top and at the bottom of the tank can be established in a similar manner to those for trim of the vessel by using the proportions following and referring to Figs. 10 and 11.

$$\frac{U\text{-}x}{x\text{-}M} = \frac{h\text{-}B' \times \text{scale of } U\text{-}U' \text{ (scale of ullage)}}{\text{Breadth of tank} \times \text{scale of } M\text{-}N' \text{ (tan } \theta \times \text{breadth)}}$$

$$\frac{U\text{-}y}{U\text{-}M} = \frac{h\text{-}A' \times \text{scale of } U\text{-}U' \text{ (scale of ullage)}}{\text{Breadth of tank} \times \text{scale of } M\text{-}N' \text{ (tan } \theta \times \text{breadth)}}$$

To find the equivalent ullage in the incorrect zones, find from the diagram the corrected ullage and also the sounding tube ullage (u) when the straight-edge intersects the corner of the incorrect zone. Subtract from the latter the ullage taken from the tank and call the difference "X." Also let

u = the ullage measured from the sounding diagram by the straight-edge, viz.: the tube ullage;

B = the breadth of the tank (mean breadth);

D = the distance from the sounding tube to the port side of the tank;

D' = the distance from the sounding tube to the starboard side of the tank.

Then when the list is to starboard, the decrease from the corrected ullage when the straight-edge intersects the corner of the incorrect zone at the top of the tank, or the decrease at the bottom of the tank, equals

$$X - \frac{X^2}{u}\left[\frac{D'}{2B}\right]$$

When the list is to port, the decrease at the top of the tank, or the increase at the bottom of the tank, equals

$$X - \frac{X^2}{u}\left[\frac{D}{2B}\right]$$

The expressions within the parentheses are constants for any given tank. Use the net corrected ullage for obtaining the capacity contained in the tank from the diagram shown in Fig. 4 as before.

These methods of determining the amount of liquid contained in a tank are absolutely accurate for rectangular tanks, but in tanks of rapidly changing form there is an error due to the fact that the center of gravity of the free surface of the liquid varies in distance from the sounding tube with changes in the list and the trim, but in practice it will be found that the average tank approximates to the rectangular form, so that the error from this source usually amounts to but a small fraction of 1 percent, and can be neglected.

The error due to the slight changes in the capillary effect between the measuring rod and the liquid in the tank, for different conditions of temperature and surfaces, may also be neglected in practice.

The Steamship New Londoner

Last spring Messrs. Irvine's Shipbuilding & Dry Docks Company, Ltd., launched from their harbor dockyard the handsome steel screw passenger and cargo steamer *New Londoner,* built for Messrs. The Tyne-Tees Steam Shipping Company, Ltd., Newcastle-on-Tyne. The vessel is designed as an intermediate steamer, suitable for their various trades. Her dimensions are as follows: Length, 275 feet by 35 feet by 16 feet 6 inches depth molded, having a long, full poop and forecastle, with a bridge 82 feet long over the poop; the poop, bridge and forecastle decks are sheathed with wood, and a steel lower deck is fitted in No. 2 hold.

The vessel is built to the highest class under the British Corporation classification, having cellular double bottom for water ballast all fore and aft, also in the fore and after peaks. She is divided into six compartments by five transverse bulkheads. Accommodation for the first class passengers is arranged in the bridge, and comprises large and well-ventilated and lighted staterooms having two berths each. The dining saloon is tastefully decorated with a dado of Chippendale mahogany, the upper panels being white and gold. Accommodation for a limited number of second class passengers is fitted in the after end of the poop. The officers and engineers' accommodation is situated in the bridge.

A promenade deck is formed amidships about 80 feet in length for the passengers, and four lifeboats are placed on this deck, giving ample boat accommodation for all the passengers and crew; a small working boat is also fitted aft. At the fore end is a large entrance hall and a spacious room for the captain, chart and wheelhouse, with a flying bridge overhead. The crew, firemen and petty officers are housed under the forecastle, where are also the lamp room, paint, stores, etc.

Particular attention has been paid to the appliances for loading and discharging the vessel, there being six powerful steam cranes and self-slewing steam winches, a 12-ton derrick being fitted at No. 1 hatch.

A complete installation of electric light is fitted throughout, including signal lamps, binnacles and clusters for each hatch, also electric bells for the first class passengers, as well as a complete outfit of oil lamps as a stand-by. A steam steering gear on the Wilson & Pirrie principle is placed in a house aft and coupled up direct to the rudder stock, with powerful screw gear in case of emergency, and a quick-warping windlass is fitted on the forecastle for hoisting the anchors.

The engines, which are of the triple-expansion type, were fitted by Messrs. Richardsons Westgarth & Company, Ltd., Hartlepool, the cylinders being 22½ inches, 37 inches and 61 inches diameter by 42 inches stroke. Steam is supplied by two large single-ended boilers working under forced draft at a pressure of 180 pounds per square inch. The design of machinery embodies the engine builders' latest practice, the main condenser being of the "Contraflo" type, with temperature regulator. The feed pumps are of the slow-speed

independent type, and work in connection with a Cascade filter tank and surface feed heater. Extra large ballast and auxiliary duplex feed pumps are provided, and other accessories in the engine room include an Aspinall's governor and mechanical lubricators of the "Octopus" type. The machinery has been constructed to the specifications of Mr. D. Belford, Newcastle, under whose supervision the contract has been carried out.

The vessel carried out progressive trials over the Whitley Bay meausred nautical mile, and ran from 9 knots up to 14½, which is her maximum speed when fully loaded. This was considered highly satisfactory, as the guaranteed speed was only 13 knots.

Molasses Tank Steamer Nelson

The steamship *Nelson*, building by the Fore River Shipbuilding Company, of Quincy, Mass., for the Cuba Distilling Company, of Habana, Cuba, was launched Aug. 12. The *Nelson* is an improved duplicate of the steamer *Currier*, built by the Fore River Shipbuilding Company and owned by the Cuba Distilling Company, and will be engaged in the transportation of molasses in bulk between Cuba, Porto Rico and American ports, principally New York. She is also constructed in such a way as to enable her to enter the transatlantic trade. The principal dimensions are as follows:

Length between perpendiculars	370 feet.
Beam, molded	52 feet.
Depth, molded to upper deck	30 feet.
Draft, loaded	23 feet.
Gross tonnage (about)	4,700 tons.
Net tonnage (about)	2,800 tons.

The vessel can be used for the transportation in bulk of molasses, oil or other liquid cargo. The total stowing capacity for molasses is 190,000 cubic feet, representing over 1,400,000 gallons. When carrying petroleum, with the oil carriage and tanks and inner bottom, the vessel will have a capacity of 1,600,000 gallons.

The vessel has three pole masts, fitted with cargo booms having a capacity of 5 tons each. The propelling machinery is located in the stern of the ship, consisting of a vertical inverted, three-cylinder, triple-expansion engine, with cylinders 25 inches by 41 inches by 68 inches, and a common stroke of 48 inches, supplied with steam at 190 pounds pressure by three single-ended Scotch boilers, working under the heated forced draft system. The engine will develop a maximum of 2,700 horsepower, which will give the vessel a speed of more than 12 knots.

For a complete description of this vessel the reader is referred to the article published on page 20 of the January, 1911, issue of International Marine Engineering, where full details, including drawings of the hull and machinery of the duplicate ship *Currier*, are given. The principal differences in the two ships lie in the general arrangement of the hull. The *Currier* has five double tanks bounded by transverse and centerline bulkheads, with a general cargo hold forward and aft of the tanks, whereas the *Nelson* has seven double tanks with no general cargo holds. The total capacity for stowing molasses is therefore greater in the newer ship, being in this case 190,000 cubic feet, representing 1,400,000 gallons of molasses, as against 138,000 cubic feet, representing 1,000,000 gallons in the *Currier*.

The propelling machinery is practically identical in both ships except for a few minor changes. The *Nelson*, however, has two 15-kilowatt, direct-connected General Electric marine generating sets, whereas the *Currier* had only one of this size. The auxiliary condenser is also larger in the *Nelson*, having 4,000 square feet of cooling surface, that on the *Currier* having only 1,002 square feet of cooling surface. This change necessitated using an auxiliary condenser circulating pump 7½ inches by 8½ inches by 10 inches on the *Nelson* in place of one 6 inches by 4 inches by 6 inches on the *Currier*. Otherwise practically the same auxiliary machinery was installed in both vessels.

LAUNCH OF THE NELSON AT THE FORE RIVER SHIPYARD

The Speediest Destroyer of the French Navy

What is said to be the fastest destroyer in the French navy is the *Bouclier*, recently built by Messrs. A. Normand & Co., Havre. On her recent official trials she maintained a speed of 35.334 knots, whereas the contract called for only 31 knots. The vessel is driven by the latest improved Parsons turbines, built by the Compagnie Electro-Mancanique, of Le Bourget, near Paris. She has the following particulars:

Length over all	233 feet 4 inches
Beam	24 feet 10 inches
Depth	16 feet 5 inches
Draft	12 feet 6 inches
Displacement, full load	660.4 tons
Contract speed	31 knots

Her hull is built with a flush deck fore and aft, except for the forecastle deck, which gives a high freeboard forward. The hull is divided into ten watertight compartments. The crew is berthed forward and the officers and petty officers aft.

The armament consists of two 4-inch, quick-firing guns, one forward and one aft; four 2.5-inch, quick-firing guns, two on each side; four 18-inch torpedo tubes; the ammunition supply includes 450 rounds per gun and 6 torpedoes.

Steam for the turbines is supplied by four oil-fired Normand watertube boilers, located in two watertight compartments. Each of them is fitted with nine Normand burners, receiving the fuel from Normand special heaters. The heating surface of each boiler is 5,277 square feet, the working pressure being 228 pounds per square inch. At full power the boilers are operated under a pressure of 4.4 inches of water.

The main engines consist of three sets of turbines, each driving a separate shaft. A high-pressure turbine drives the center shaft, and two low-pressure turbines drive the wing shafts. They have been designed to work at 1,000 revolutions per minute, the propellers being 5 feet 3 inches diameter and 4 feet 11 inches pitch.

The results obtained on the full-power trial were as follows:

Duration of trial, hours	6
Trial displacement, tons	660.44
Pressure at boiler, pounds	217
Pressure at steam chest, pounds	183
Pressure of fuel at burners, pounds	143
Revolutions, average	1,034.02
Speed, average knots	35.334
Speed, contracted, knots	31
Shaft-horsepower	15,000
Vacuum, inches	28
Fuel consumption per hour, pounds	21,192
Fuel consumption per contract, pounds	29,781
Fuel consumption per shaft-horsepower, pounds	1.46
Eight-hour consumption trial:	
Revolutions per minute, average	325.18
Speed, average knots	14.06
Brake-horsepower	1,400
Vacuum, inches	28.1
Consumption per hour, pounds	1,915
Consumption per shaft-horsepower, pounds	1.36

A Diesel Motor Tank Vessel

BY DR. ALFRED GRADENWITZ

The German-American Petroleum Company, which already commands twenty-three steamers, aggregating more than 84,000 gross tons, has entrusted several firms of German shipbuilders with the construction of some further vessels intended for the transport of petroleum between Europe on one side and North America or the Far East on the other, thus increasing and partly renovating its present fleet. Part of these new vessels—all of which are being designed as tank vessels—will be propelled by motors, thus embodying for the first time in this special branch of shipbuilding an undoubted advance, which, quite apart from other reasons, would seem to deserve early imitation because of the reduced fire risk.

Among the motor vessels ordered in this connection, a tank vessel of about 15,000 tons carrying capacity seems to be of more than passing interest, because of its extraordinary dimensions. Apart from being the largest motor ship so far in existence it will, in fact, be the largest tank vessel so far constructed.

This vessel is being built by Messrs. Krupp Germaniawerft, of Kiel, according to the new Isherwood longitudinal frame system, as a shelter-deck vessel carrying three continuous decks. Its dimensions will be as follows:

Length	528 feet.
Breadth	66.63 feet.
Height at sides	41.48 feet.

As owing to special arrangements nearly the whole upper 'tween deck is left out of account, the net tonnage is relatively small as compared with the dimensions of the vessel.

The tanks occupy about two-thirds of the length of the vessel, being divided by transverse bulkheads into eleven compartments, each of which is in turn sub-divided into two separate tanks by a continuous longitudinal central bulkhead. These tanks are continued as far as the third deck, whence an expansion shaft extending the whole length of the tanks goes to the second deck, taking up one-quarter of the whole breadth, and thus reducing the freely-moving surface of the liquid cargo to one-quarter of the breadth of the vessel. Beside the walls of this expansion shaft there are arranged some "summer" tanks, intended on one hand to afford additional carrying capacity for an oil load of lower specific weight than the average petroleum, and on the other to allow existing regulations in regard to the load-line to be more easily complied with in the different seasons of the year. In order to protect the terminal compartments against any invasion of oil in case of leakage of the tanks, cofferdams, consisting of a shelter formed by two bulkheads, are fitted into their forward and after ends. Another cofferdam inserted between the tanks No. 2 and No. 3 allows different kinds of oil to be safely separated from one another.

Between tanks No. 5 and No. 6 there is provided a pump room containing steam pumps of 15.2 inches and 12.4 inches cylinder diameter, respectively, and 18.4 inches stroke, which are able in a short time to empty the holds. Arrangements have also been provided for allowing these pumps to be used as suction pumps, drawing in the oil from the shore. The suction and pressure pipes are so arranged as to allow the pumps to draw in the oil from any tank, transferring it into any tank desired.

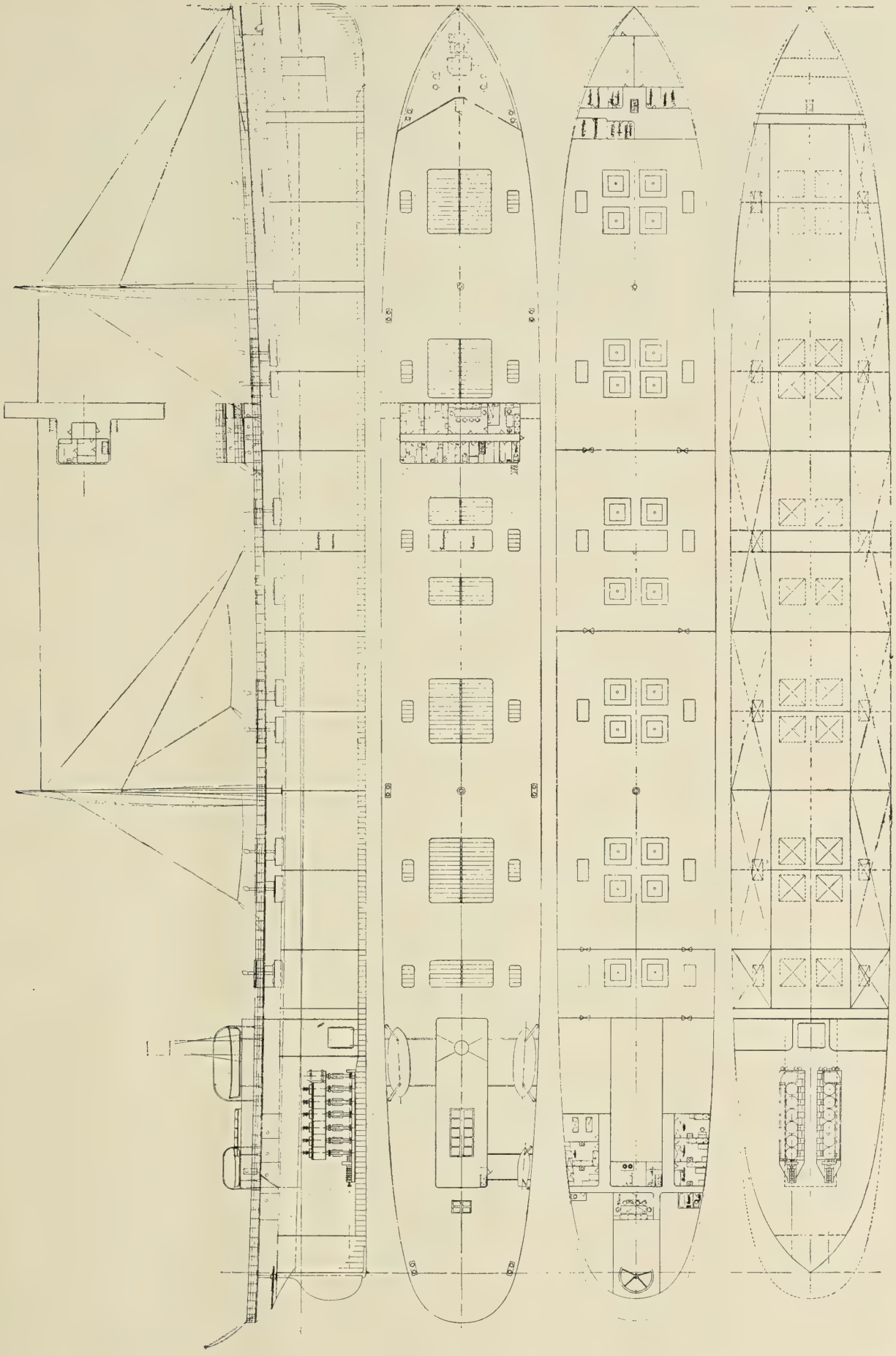
In order to allow the holds to be entered without any risk for the sake of inspection or repair work, any residual poisonous gases should be removed, allowing fresh air to take their place. To effect this the suction pipes of the holds can be connected to a powerful steam-driven fan drawing off in a short time any poisonous gases and throwing in fresh air into the tank. This ventilation is activated considerably by blowing steam into the holds. Moreover, all the holds are well ventilated, the discharge tubes being carried up the masts.

Two single-action, two-cycle Diesel motors, designed according to the Germania Shipyard's special system, are used to propel the vessel. These two motors, with about 125 revolutions per minute, yield a total output of about 3,500 effective horsepower, imparting to the vessel an ocean speed of 10 knots.

The electric light and power plant comprises two 110-volt dynamos, direct coupled to engines of 35 horsepower each. Electric drive is provided for a fire pump, a deck rinsing pump, a ballast pump and an oil pump destined to replenish the fuel tank. Some further pumps in the engine room for the transfer of ballast or fuel are operated either by steam or by compressed aid generated by the motors. In a similar manner the rudder machine, while being generally driven by compressed air, is provided with steam connections.

The steam required for heating as well as for operating the two oil pumps, the oil transfer pump, ballast pump and the dynamo is generated in a small auxiliary boiler designed for oil fuel.

The new vessel has been assigned the highest class of the British Lloyds ✠ 100 A-1, and is being fitted up with the most up-to-date arrangements, corresponding to the latest advances in engineering.



LONGITUDINALLY FRAMED DIESEL ENGINED TANK VESSEL OF 15,000 TONS CARRYING CAPACITY

Plans for a New Steamship Terminal in New York Harbor

BY H. McL. HARDING*

On account of the congestion along the waterfront of the Island of Manhattan there are now some thirty-three companies unable to obtain berthing facilities, and it is necessary that other locations at the port of New York be found where large terminals can be advantageously situated.

It is essential that at a place to be selected for such a terminal it should be possible to successfully fulfill all the requirements of a modern terminal, so as to secure rapidity and economy of transference, and that it should be in every respect a transhipment terminal. It should not be chiefly a railway terminal with classification yards, transfer and distributing yards predominating, but a combination of all that make up a correctly planned terminal, with all the elements properly proportioned. Not only must provision be made for the foreign and coastwise commerce, but also for the transcontinental and intercoastal commerce.

In addition, there are the fast-freight export shipments, now becoming so important, which give emphasis to the necessity for the rapid handling of freight at any terminal.

As discussed at the last International Congress of Navigation, held in Philadelphia in May and June of this year, it was recognized that a terminal consisted of a number of important elements, none of which could be dispensed with if the terminal was to be able to compete successfully with other cities for the ever-increasing foreign and domestic trade. A terminal must have all its elements co-ordinated or tied together; that is, the warehouses, industrial sections, railroad tracks, the outbound and inbound houses, each with their respective tracks and platforms, the transfer station, classification yards, car storage yards with ample placement tracks supplementing the transfer station; then the sheds rearward of the piers, the piers, wharves, and the latest type of transit sheds, and all of these connected by such standard mechanical transferring appliances as have proved most successful.

Location

As the through or commercial traffic, inland, even to the Middle West, including the domestic as well as the foreign, comprises a large proportion of the total freight handled in New York harbor, a terminal to provide for this must be so arranged that the freight can be transferred, as far as the character of the freight will permit, directly between the vessel and the car, thereby avoiding the expense of rehandling by manual labor, of lighterage, which costs 60 cents (2/6) or more per ton, and of high land rental or interest, which must be charged to every ton. The reduction in the expense for manual labor alone for this transference will be about 20 cents (0/10) per ton. There is also a possible saving, due to the rapidity of transference, in the charter value of steamships estimated at 12 cents (0/6) per ton. If all the possible economies can be effected there will be a positive saving of 60 cents (2/6) lighterage, plus 18 cents (0/9) pier rental, plus 20 cents (0/10) mechanical transferring, plus 12 cents (0/6) charter value saving in time, making a total saving of $1.10 (4/7) per ton.

To eliminate the lighterage charges for this through or commercial freight, the terminal can be located most advantageously on the mainland of New Jersey, but not in such places as would require bridges or long trestles near the terminals to connect with the West, and not on wholly or partially submerged Government or State lands. There must also be the possibility of connecting with two or more competing railways.

At first it seemed impossible to satisfy all these conditions, but finally, after much difficulty, between 900 and 1,000 acres were purchased on the mainland of New Jersey at the junction of the Staten Island Sound and the Rahway River, and plans have been prepared for the erection there of a modern steamship terminal to be known as the Montgomery Terminal. The site is about midway between the Raritan Bay and the Kill von Kull and to the west of Staten Island, thereby securing a protected waterway either to the North or to the South.

The width of Staten Island Sound opposite the Montgomery Terminal is about the same as the Thames at London, and by dredging the point of an island now controlled by the terminal a width of nearly half a mile can be secured. Below the terminal the Sound gradually widens.

Through this Sound there passes a traffic of nearly 30,000,000 tons annually. There is a depth of 21½ feet at low water and above 26 feet at high water.

Capacity of Terminal

As planned there will finally be a track capacity pertaining to the terminal of not less than 30 miles and a car placement of some 3,000 cars. This trackage will include the distributing leads, storage tracks and sidings.

The transferring capacity per lineal frontage of quay or pier wall, as planned, provides for not less than 4,000,000 tons annually. This is based upon the experience of many ports, even those not equipped with modern appliances. The estimate is most conservative.

Within the slips and along the quay walls of the Staten Island Sound section the plans provide for berthing facilities for twelve large-sized freighters at the same time, and further development will add eleven more, besides space for a number of barges and lighters.

Upon the north side of the Rahway River, and along the quay walls of the basin, there will be berthing facilities for thirteen additional large freighters, besides room for barges and lighters. Upon the south side of the river there will be berthing frontage for thirteen additional steamships.

It is to be noted that the river and basin constitute an enclosed tidal dock similar to those of foreign ports.

Instead of giving the number of square feet of the floor area of the sheds or other buildings as a capacity unit, which are generally considered as tiering the goods only 5 feet in height, it is more correct to give the available or effective cubical contents in terms of tonnage-holding capacity. Allowing 100 cubic feet per ton instead of 40 cubic feet per marine ton, and which is nearer correct for miscellaneous freight, and tiering 20 feet in height, due allowance being made for passageways, then the holding capacity of the five pier sheds, as shown, each one story in height, would be a total of 61,200 tons. The sheds are of such height that the miscellaneous freight can be tiered 10 feet higher, proper consideration being given to the character of the freight.

As shown, there are twenty-seven land sheds, each 400 feet by 100 feet, and of one and one-half stories in height. Using the upper story for holding, or in some cases for storage, supplemented by the temporary holding capacity of the first half-story, there would be a total holding capacity in the twenty-seven sheds of 183,600 tons.

Six warehouses are provided, each 100 feet by 300 feet, and these will have a total storage capacity of 72,000 tons. These warehouses are so arranged that they can be extended 300

* Consulting engineer, 17 Battery Place, New York.

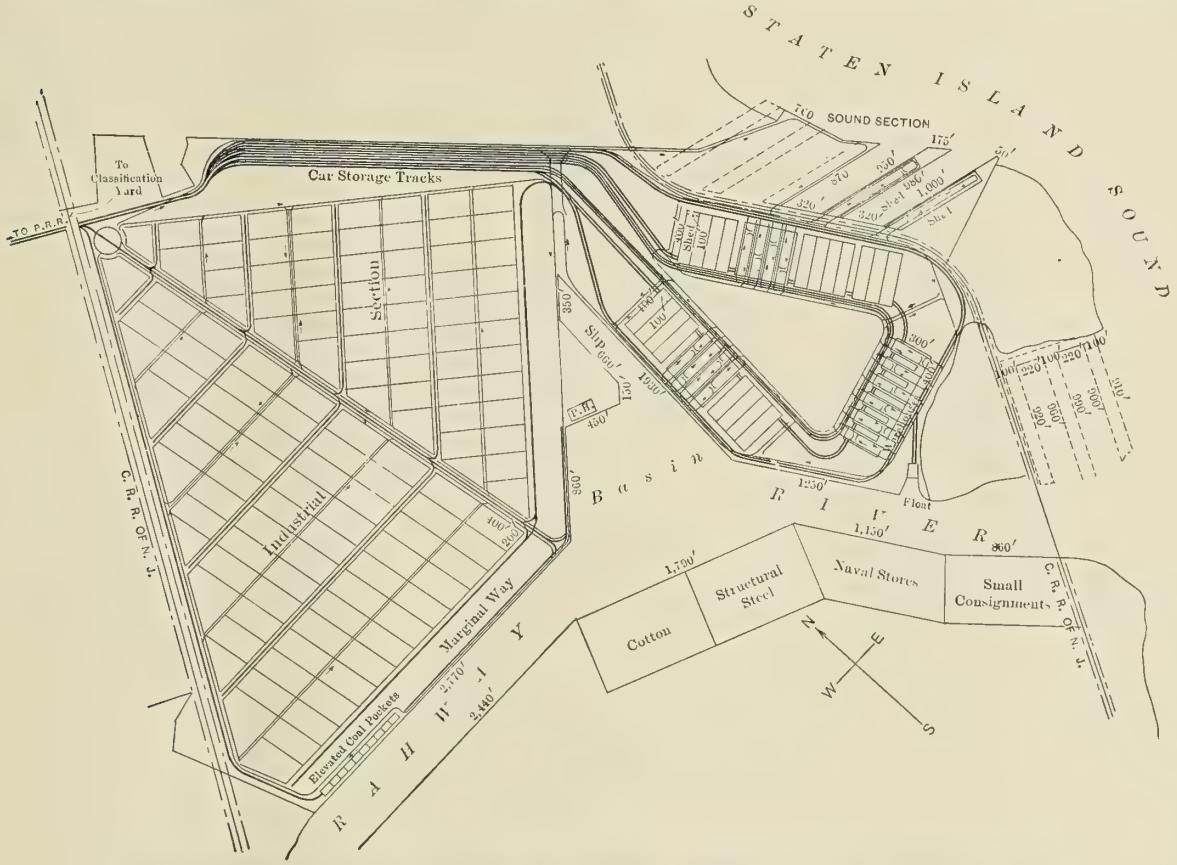
feet further towards the north, thereby doubling the storage capacity.

Railway Connections

This terminal is so located as to have direct railway connection with two lines of the Central Railroad of New Jersey, the main line of the Pennsylvania Railroad, and either directly or through other lines with the Lehigh Valley, the Baltimore & Ohio, the Philadelphia & Reading, the Erie, the West Shore, and by water with the New York Central and the New York, New Haven & Hartford.

Sheds

The sheds about the slips will be constructed of steel frames with corrugated walls with reinforced concrete foundations. The sheds directly back of the piers on the Sound section and to the east of the basin constitute what may be called warehouse sheds. There have been planned seven groups, each of four buildings, making twenty-eight in all, to be built as needed and divided by fire walls. They will be one and one-



PLAN FOR MONTGOMERY TERMINAL ON NEW JERSEY MAINLAND, STATEN ISLAND SOUND, PORT OF NEW YORK

half stories in height of steel frame on reinforced concrete foundation. The walls will be of reinforced concrete and the roofs of cement tile.

The warehouses proper will be of similar but heavier construction, with walls of reinforced concrete and of several stories in height.

In the beginning there will be two groups of these warehouses, each composed of three buildings. The large cotton sheds will finally be located south of the river, and will be of reinforced concrete, divided into sections by concrete partitions, each partition to hold the limited number of bales as required by the underwriters.

According to the latest methods at other terminals the roofs of these sheds will consist of movable roof panels, so constructed as to form rolling hatches, which can be moved to one side, so that the whole or part of a roof can be opened, and through these roof hatches loads can be raised or lowered by modern machinery, and by one operation transported to or from a ship's hold.

These details, as to the type of building and the handling of cotton and other commodities, have been carefully worked out for each class of freight. A distinction will be made between the type and location of warehouses for long storage; that is, for a number of months, and for what may be called "transit freight warehouses" in distinction from the transhipment sheds. As soon as the volume of business requires it, it is planned to locate the long-storage warehouses in the industrial section.

According to the "Report on Terminals," by the Hon. Herbert Knox Smith, formerly Commissioner of Corporations of the United States, one of the essential elements of a terminal is the industrial section. This space, as shown, has been laid out for industrial lofts, and for the larger as well as for the smaller industrial establishments.

To the rear of this section, to the west, is a large area for additional trackage, other industrial establishments and the residential section. This has been designated as the industrial area, a distinction from the industrial section.

Transferring Mechanism

In order to determine what classes of machinery should be installed, so as to secure the greatest rapidity and the least cost of transference, the different kinds of commodities to be handled should be separately considered.

For mechanical transhipment freight can be divided into two great classes; the first being bulk freight, such as ore, coal, phosphate and sulphur, and the second, miscellaneous cargoes of steamships and the package freight of cars, consisting of boxes, barrels, cases, packages of every kind, size, weight and description, from a grand piano or a hogshead of tobacco, to a crate of eggs or a case of feather-weight millinery.

In addition, there are cargoes of one commodity, but often of many marks, such as cotton, sugar, coffee, rice and bales of many kinds of material. These would be handled by the same class of machinery as package freight. There is, moreover, a third class, consisting of exceptionally heavy or bulky units which cannot well be divided, for which a few special machines are adapted.

The movement of bulk material is generally between two points only, and the chief requirement is continuous rapidity. This is attained by means of grab buckets of various types in combination with link belt conveyors or various forms of rubber belt conveyors, moving platforms or chains.

Locomotive cranes can often be advantageously employed, but at terminals where there is a large proportion of waterfront to the terminal area, a floating crane is of the greatest utility. It can be easily moved from one place to another, and, equipped with a grab or clam-shell bucket, can unload bulk material rapidly, or with hooks instead of the buckets can take the place of the stationary crane for heavy weights or bulky material.

At a terminal where electricity will be exclusively employed, such a floating crane will be furnished with electric motors, and arrangements will be made for "plugging in" at convenient intervals.

Miscellaneous freight-handling appliances and those of more universal application, may be considered under three classes.

The first is the ship's winch, which, when there are several operating at one hatch, gives good economy, and would give a fair rapidity were it not for the congestion at the place of landing upon the pier. In some cases a platform is pushed out from the side of the pier at the first or second story for the reception of these miscellaneous packages.

Realizing the great disadvantage of this congestion and the limitation of the ship's winch the engineers at all important foreign ports have installed cranes of the traveling gantry type. In some cases, as at Hamburg, over 130 of these cranes have been installed around a single dock at a total cost of over $600,000 (£123,000). It is proved by this universal custom abroad that it is not profitable for ships to use their winches on account of the detention of the ship. As the charter value of a ship may be $400 (£82) or more per day, the saving in the time of loading and discharging is of financial importance.

The ship's winch is confined in its action to about 6 feet from the edge of the pier. The gantry will serve a half circle of 35 feet radius. In each case the next movement involves the great expense for the manual labor of rehandling.

In working out the plans for the Montgomery Terminal it was determined to carry out the resolution according to the programme of the International Congress of Navigation, that by mechanical appliances it should be possible to serve directly all places within the limits of the terminal. This means that by mechanical appliances it should be possible to transfer the freight between the vessel and any portion of the pier or pier shed, including tiering, or the bulkhead, the car platforms, the dray areas and platforms, the warehouse yards, marginal way and the industrial section continuously, rapidly and without rehandling.

To achieve these conditions of far distant hoisting and conveying it has been determined to use "transferage" or cross-space conveying, and to install movable tracks, whereby one movable track, at a far less expense, would replace many stationary, cross-gridironing tracks of the older methods, serving all space by the machinery which no stationary tracks could do.

To secure these results most satisfactorily the best type of connection between the fixed and movable cross tracks was selected. One of these types of switches is called a glider, or gliding switch, and another the opening glider, which latter permits the transferring machinery to pass by the switch, continuing in a straight line, or to take a movable cross-over or the movable loop track. This latter type is controlled by the transferman from his cab.

All parts of the terminal, including the industrial section, are connected by the above overhead runways, and also by surface railroad tracks for full carloads. The industrial sections are also connected with the berthing locations of the waterfront, all railway platforms and the team track section.

According to this arrangement freight when delivered upon the piers, bulkheads, marginal way, if a carload lot, is conveyed by surface railway to its destination about the terminal. A small waterborne consignment, or portion of a mixed carload, is transported directly to its place by overhead runways, whether to the shed, warehouse or factory. This ease and flexibility of shipping and receiving goods make the industrial sections remote from the waterfront equally valuable with those adjoining the marginal way.

The number of tractors and transfer trailer hoists will depend upon the tonnage to be transferred, and any or all of the tractors and transfers can be concentrated at any portion of the terminal for quick transferring. At some locations the transferage system will be supplemented by the walking gantry crane, and at others by the ship's winch. Hinged loops, or movable projection loops, will be arranged to extend over the ship's hatches and decks and also to serve barges and lighters.

The great points of advantage which such a terminal possesses are its great land area, its railroad connections, its location and the superiority of its transferring machinery, so as to secure the lower transhipment costs and less ship detention, due to the rapidity of loading and discharging by such appliances.

Quarterly Report of Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

BATTLESHIPS

	Tons.	Knots.		May 1.	Aug. 1.
Wyoming	27,000	20½	Wm. Cramp & Sons	97.0	99.3
Arkansas	27,000	20½	New York Shipb'g Co	96.0	99.3
New York.	28,000	21	Navy Yard, New York	35.3	48.2
Texas	28,000	21	Newport News Shipb'g Co	61.0	72.1
Nevada	28,000	20½	Fore River Shipb'g Co	0.0	4.0
Oklahoma	28,000	20½	New York Shipb'g Co	0.7	3.3

TORPEDO BOAT DESTROYERS

Jarvis	742	29½	New York Shipb'g Co	80.2	90.8
Henley	742	29½	Fore River Shipb'g Co	75.1	93.6
Beale	742	29½	Wm. Cramp & Sons	78.9	97.0
Cassin	742	29½	Bath Iron Works	15.6	42.3
Cummings	742	29½	Bath Iron Works	15.5	30.7
Downes	742	29½	New York Shipb'g Co	10.7	16.4
Duncan	742	29½	Fore River Shipb'g Co	18.1	34.3
Aylwin	742	29½	Wm. Cramp & Sons	18.4	48.0
Parker	742	20½	Wm. Cramp & Sons	16.4	42.2
Benham	742	29½	Wm. Cramp & Sons	17.1	38.9
Balch	742	29½	Wm. Cramp & Sons	14.4	37.3

SUBMARINE TORPEDO BOATS

F-3	....	....	Seattle Con. & D. D. Co	91.3	99.9
F-4	....	....	Seattle Con. & D. D. Co	90.6	90.8
G-4	....	....	Wm. Cramp & Sons	73.5	79.5
G-2	....	....	Newport News Shipb'g Co	85.8	86.0
G-1	....	....	Lake T. B. Co	90.2	91.1
H-1	....	....	Union Iron Works	66.3	76.2
H-2	....	....	Union Iron Works	66.5	75.7
H-3	....	....	Seattle Con. & D. D. Co	63.6	73.3
G-3	....	....	Lake T. B. Co	46.6	54.9
K-1	....	....	Fore River Shipb'g Co	30.8	43.9
K-2	....	....	Fore River Shipb'g Co	30.1	43.4
K-3	....	....	Union Iron Works	36.6	47.9
K-4	....	....	Seattle Con. & D. D. Co	30.2	40.7
K-5	....	....	Fore River Shipb'g Co	13.5	26.2
K-6	....	....	Fore River Shipb'g Co	13.5	25.8
K-7	....	....	Union Iron Works	17.5	28.2
K-8	....	....	Union Iron Works	17.5	28.2

COLLIERS

Proteus	20,000	14	Newport News Shipb'g Co	54.8	61.9
Nereus	20,000	14	Newport News Shipb'g Co	46.9	56.7
Orion	20,000	14	Maryland Steel Co	77.1	99.9
Jason	20,000	14	Maryland Steel Co	36.9	47.7
Jupiter	20,000	14	Navy Yard, Mare Island	62.0	78.2

The New Floating Dry-Docks for the British Admiralty

BY FREDERICK C. COLEMAN

The two floating docks ordered some two years ago by the British Admiralty for the accommodation of dreadnought and super-dreadnought battleships—one for Sheerness from Messrs. Swan, Hunter & Wigham Richardson, Ltd., of Wallsend-on-Tyne, and the other, to be stationed at Portsmouth, from Messrs. Cammell Laird & Company, Ltd., of Birkenhead—have now been completed, and in the accompanying engravings is illustrated the Sheerness Dock. This dock, like that for Portsmouth, has been built from the designs of Messrs. Clark & Standfield, of Westminster, and it is of the "box" type, with two side walls; that is to say, on each side of the pontoon proper and running almost the full length of it there is erected a side wall. Not only are these side walls permanently attached to the pontoon but the dock cannot be taken apart in any other way. This broadly constitutes the difference between the "box" dock and docks of the "self-docking" type. The latter are built in detachable sections, so that one or more portions of the dock can raise the remainder for purposes of cleaning, painting and repairing.

FIG. 1.—GENERAL VIEW OF 32,000-TON ADMIRALTY FLOATING DRY-DOCK

The dock illustrated is intended for working in connection with the Chatham Dockyard, and it has been berthed at moorings specially laid down by the British Admiralty in Salt Pan Reach, in the River Medway, near Port Victoria, Sheerness. From the dimensions on the drawings of the dock (not shown) the dock is 680 feet in length over platforms, 640 feet ¾ inch in length over the pontoons, and 144 feet ¾ inch in width. The clear width between the rubbing timbers on the top deck is 113 feet. The side walls are 65 feet 6⅝ inches in height on the outside of the dock and 46 feet 5⅞ inches above the pontoon. In length they are 520 feet ¾ inch along the pontoon deck and 440 feet ¼ inch at the top. The depth of the pontoon is 19 feet 6¾ inches. The total area occupied by the dock is no less than 2¼ acres.

Fig. 4 affords a good view of an early stage in the construction, as it shows the bottom plating entirely laid and some of the bulkheads of the bottom pontoon erected. The height of these bulkheads, or, in other words, the depth of the pontoon, is 19 feet 6¾ inches. Overhead are shown the four great cantilever electric traveling cranes, which have proved invaluable in lifting material for the dock and placing it in position. It was under the great building shed shown on the left side of some of the illustrations that the *Mauretania* was built. The weight of steel plates and angles worked into the dock amounts to about 12,000 tons. The keel blocks, of English oak, are spread over a length of 640 feet, and the two lines of bilge blocks on each side cover a length of 280 feet, and Fig. 1, which is from a photograph taken from one end

of the dock as she was moored, shows the arrangement of the three lines of keel blocks and also gives a good idea of the length of the dock. At the bow end of the dock there is a pair of flying gangways of lattice construction, giving access from one wall to the other.

The mooring arrangements are unusually large and strong so as to efficiently hold the dock in a tideway. At each end of each wall there is a strong timber roller fender to assist in the guiding of vessels when being docked. Up the face of each wall are accommodation ladders, giving access from the pontoon dock to the top of the walls, and details of these are shown in Fig. 4, which also illustrates the three platforms which run along the inside of each wall below the top decks.

FIG. 2.—LATHE SHOP IN STARBOARD WALL OF ADMIRALTY DOCK

At the forward end of the starboard wall is placed the valve house, from which are controlled all the valves and pumping arrangements for the various compartments of the dock.

The valve operating gear is of the Westinghouse electro-pneumatic system, which has been in use for the working of points and signals on railways in all parts of the world since 1892, and has since been adopted for the operation of the water valves on floating docks. The presses are operated by air, compressed to five or six atmospheres, and controlled by means of valves operated by an electro-magnet. When the magnet is energized (*i. e.*, after the slide lever in the valve house has been pulled over) the exhaust passage of the valve is closed and the inlet opened, and the air passes into the press and thereby lifts the hydraulic valve. The position of this apparatus is indicated back to the valve house by means of the circuit breaker shown to the left of the press, the arm of which has the same travel as the press and hydraulic valve. All the time the magnet remains energized the valve is lifted, but when the current is cut off by the movement of the slide lever in the valve house the air is expelled by the weight of the valve and rod. Should the electric current fail the electro-magnets can be operated by hand, and also, if the air pressure should fail, the valve can be opened by the hand-lifting gear provided above the stirrup of the press.

The bottom pontoon is divided both longitudinally and transversely by a number of watertight bulkheads, and the two side walls each have a watertight deck running along their whole length. These bulkheads and decks divide the pontoon and walls into about eighty watertight compartments. These are grouped into sections, each of which has its own set of valves, so that it can be flooded or emptied independently. Telephones connect the various machine spaces with the principal control station.

In the port wall there is living accommodation for the dock master, petty officers and dock crew, and also messrooms, lavatories, etc.

At each end of each wall are two steam boilers, each working at a pressure of 155 pounds per square inch, and all of these were built at the Neptune Works of Messrs. Swan, Hunter & Wigham Richardson, Ltd.

The pumping machinery comprises eight sets of compound diagonal type steam engines with eight sets of 16-inch vertical standard centrifugal pumps, supplied by Messrs. Gwynnes, Ltd., of the Hammersmith Iron Works, London, and working at 275 revolutions per minute. In each wall are also placed

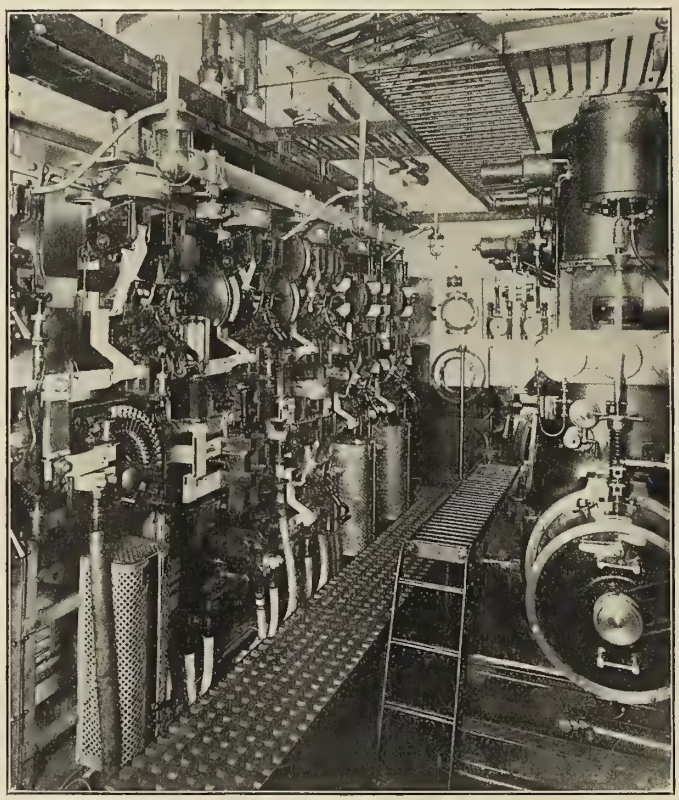


FIG. 3.—DYNAMO ROOM

two direct-acting Worthington steam pumps, capable of delivering 400 gallons of water a minute, and these are intended for fire and wash-down service.

In order to warp ships into position eight powerful steam-driven capstans, by Messrs. Hartfields, of London, are fitted on the walls, and there are also placed on top of the walls two 5-ton electric cranes, supplied by Messrs. Joseph Booth & Bros., Ltd., of Rodley, Leeds, each capable of working through a radius of 60 feet.

Fig. 3 is a view of the dynamo room to be found in each wall. The machinery consists of duplicate sets of Messrs. Browett, Lindley & Company's two-crank compound enclosed engines, running with forced lubrication at 400 revolutions per minute, and each driving a Westinghouse direct-current gen-

erator. The engines have cylinders 16 inches and 24 inches diameter by 10 inches stroke, and they are mounted on an under-base, which also carries the generator. They are fitted with a shaft-throttle governor, also an emergency safety governor, which can be worked either by hand or automatically from the main governor when the speed increases 10 percent. The pistons are fitted with restrained type piston rings. The piston rod and valve rods for both high-pressure and low-pressure cylinders are fitted with metallic packing. Each set is capable of developing 310 brake-horsepower (210 kilowatts) as a normal load with 140 to 150 pounds steam pressure working non-condensing, an overload of 10 percent for two hours with 110 pounds steam pressure, condensing and non-condensing, also to develop full load with 100 pounds steam pressure and 50 percent overload for short periods with increased steam pressure.

This equipment of electrical machinery supplies current for driving the machinery in the workshops, the traveling cranes, the valve gear, lighting, etc., and also power and light for any warship that may be in the dock. At the top of the walls are placed large electric arc lamps hanging from revolving standards, and in addition to these there are numerous portable clusters of lamps.

In each wall of the dock there is an air compressor, supplied by Messrs. Alley & Maclellan, of Glasgow, which provides power for the electric pneumatic valve operating gear, and also pneumatic tools, of which there is a complete equipment.

In the starboard wall there is a complete range of workshops, comprising a smithy, lathe shop, machine shop and coppersmiths' shop. In the smithy is a flanging machine, by Messrs. Bertrams, of Edinburgh; punching and shearing machines, by Messrs. Hulse & Company, Ltd., of Manchester; smiths' forges, by Messrs. Alldays & Onions Pneumatic Engineering Company, Ltd., of Birmingham, and a 5-cwt. power hammer, by Messrs. Peter Pilkington, Ltd., of Preston, Lancs. In the lathe shop are five center high-speed lathes and one 6-foot chock lathe, all supplied by Messrs. Dean, Smith & Grace, Ltd., of Keighley, Yorks., and one horizontal boring and milling machine by John Holroyd & Company, Ltd., of Milnrow, near Rochdale. In the machine shops are various machines for milling, drilling and planing, and also a belt-driven hack-saw. In the coppersmiths' shop is a hydraulic copper pipe-bending machine, supplied by the Leeds Engineering & Hydraulic Company, and two coppersmiths' hearths, by Messrs. Alldays & Onions.

The dock is designed to lift battleships up to displacements of 32,000 tons, having a maximum draft of 36 feet, and was built at a cost of approximately $1,314,000 (£270,000).

The dock left the Tyne in the middle of June, and was towed to the Medway in charge of four tugs of Messrs. L. Smit & Company's Sleepdienst, Ltd., of Rotterdam.

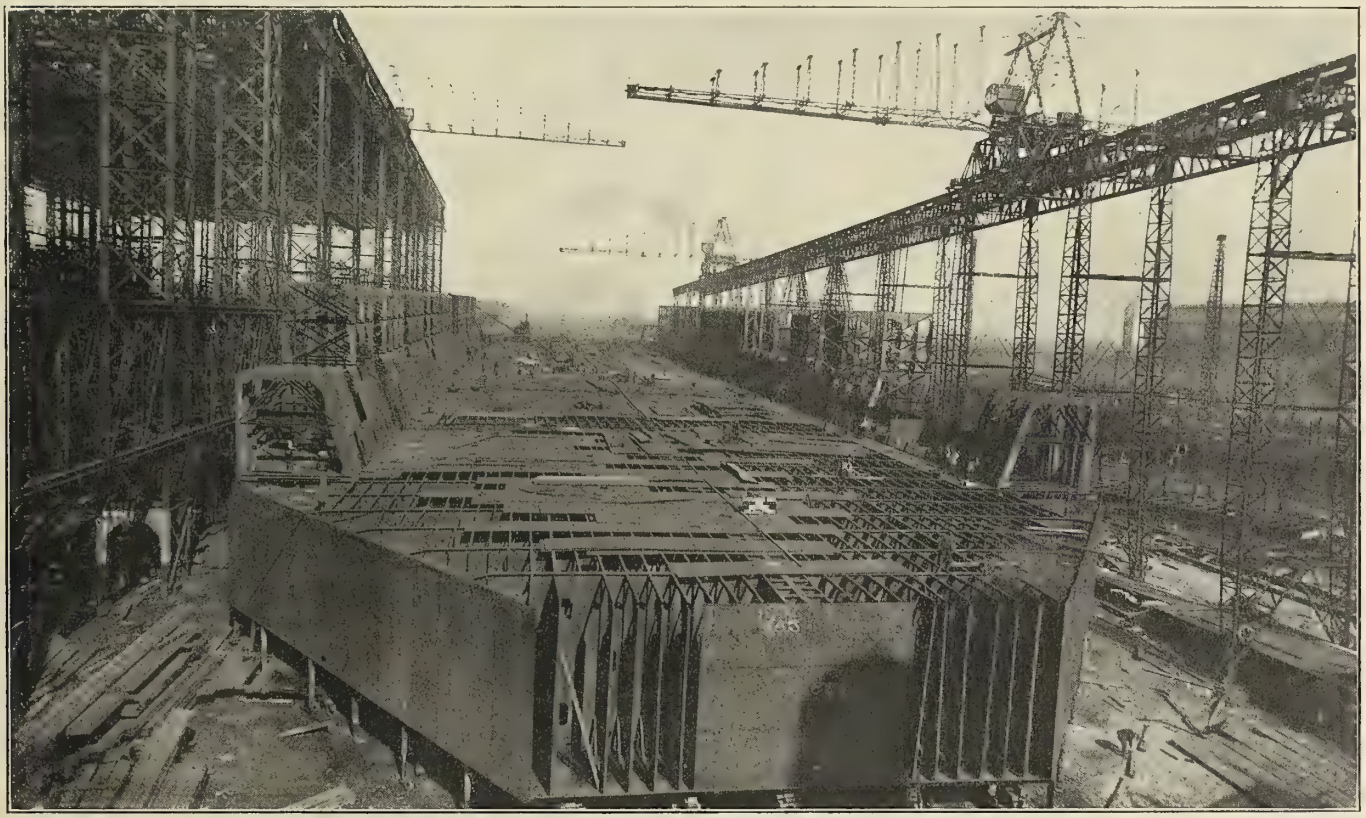


FIG. 4.—DOCK UNDER CONSTRUCTION, SHOWING SUBDIVISION OF BOTTOM PONTOON AND SIDE WALLS

We understand that the departmental committee recently appointed by the president of the Board of Trade to advise on the watertight subdivision of merchant ships of all classes, is now about to consider the question of the construction and fitting of watertight doors. Those makers who desire to bring their inventions to the notice of the committee can do so by writing, in the first instance, to the secretary of the bulkheads committee, Board of Trade, Whitehall Gardens, London, giving an outline of what they wish the committee to consider with relative papers. It would be well for inventors who are not engineers or naval architects to take expert advice before sending in their proposals.

The Bureau of Navigation reports 191 sailing, steam and unrigged vessels of 28,241 gross tons built in the United States and officially numbered during the month of July. Of these five steel steamers, aggregating 4,505 gross tons, were built on the Atlantic and Gulf coasts, and six, aggregating 5,288 gross tons, were built on the Great Lakes.

Performance of Notable Sea-Going Diesel Engined Vessels

BY F. MULLER VAN BRAKEL

From time to time INTERNATIONAL MARINE ENGINEERING has published articles describing ships propelled by Diesel engines. Most of the ships mentioned have been either auxiliary motor ships (as, for instance, the splendid big sailing vessels *Queville* and *France* or smaller craft for river or coastwise use. With the exception of the *Toiler* and the *Selandia* no real sea-going cargo traders have been described. But if the Diesel engine is going to revolutionize the shipping world it should be capable of driving the ordinary cargo boat—that is, the tramp. Small, high-speed Diesel engines, as constructed in Germany for submarines, may be very useful, but a new type of propelling machinery for cargo carriers is of far greater importance.

In the following a description will be given of the ocean-going cargo boat *Vulcanus*, which is propelled by Werkspoor Diesel engines. This description will be followed by a brief account of the experiences with this boat at sea, by some particulars from the fuel bill and by the opinion of the ship-owners, as expressed in the order book of the Werkspoor Works.

DIESEL ENGINED CARGO BOAT VULCANUS

THE HULL

The *Vulcanus* was built by the Nederlandsche Shipbuilding Company, Amsterdam, to the order of the Anglo Saxon Oil Company. It is an oil-tank ship of the turret-deck type, 196 feet by 37 feet 9 inches by 13 feet 2½ inches, displacing, when fully loaded, 1,900 tons. Its deadweight capacity at the maximum draft of 7 feet 6 inches is 1,000 tons. There is a short bridge deck house amidships and another deck house aft for the accommodation of the officers, pilot, etc. Two short pole masts are fitted with loading tackle to handle the cargo when no oil is carried. The four windlasses and the winch are driven by compressed air, which in a Diesel ship is always at hand. The engine room is aft, and as the combustion gases are discharged through a funnel the ship looks very much like a steamer, except that the funnel never gives out any smoke.

The hull, built to Lloyd's highest class, is similar to the ordinary tank vessel with a longitudinal bulkhead and several transverse bulkheads, which divide the hull into cargo holds, a pump room and engine room. Two cofferdams are built, one forward and one aft of the cargo space.

PROPELLING MACHINERY

The engines and auxiliaries were designed and built by the Werkspoor Works, of Amsterdam. This firm has for many years engined a great number of passenger and cargo steamers, and for the last fifteen years has taken up the construction of Diesel engines. The experience gained by the construction of marine steam engines was of great benefit when the oil engines for the *Vulcanus* were designed, because the knowledge and skill of the men who will have to handle the machinery should be taken into account when a ship is fitted out with a new type of engine. The Werkspoor Works, therefore, endeavored to design a Diesel engine which, besides proving reliable, would conform as closely as possible to the marine steam engine, especially in the design of details. The result was an engine whose details were at once quite familiar to the marine steam engineer, who is accustomed to short pistons with rods and cross-heads and eccentrics and eccentric rods, all of which are found in the Werkspoor Diesel engines, so if any accidents happen the engineer will know from experience how to tackle the job.

The principal differences in construction between the Werkspoor marine Diesel and other Diesel motors are, briefly:

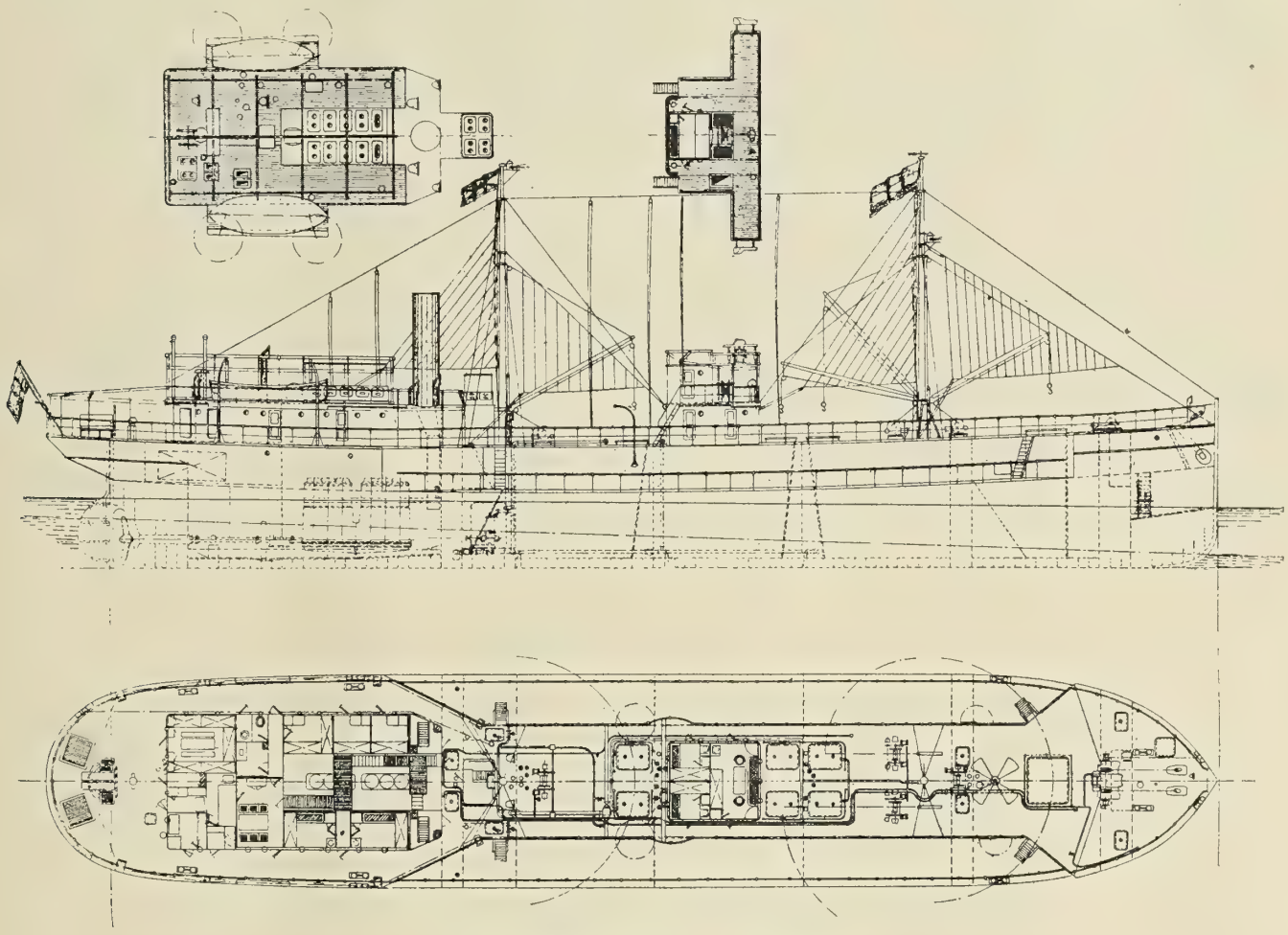
(1) The trunk piston with many rings has been replaced by a rather short piston, not subjected to any side thrust but fitted with piston rod and cross-head.

(2) The camshafts are not driven by vertical transmission shafts and spiral gears but by means of a pinion working on two spur wheels fitted, respectively, on the camshaft for ahead and on that for astern motion.

(3) The vertical shaft has been replaced by two eccentric rods.

The main engine is a single-acting, four-cycle motor, developing 500 horsepower at 165 revolutions per minute. The low number of revolutions will be appreciated by engineers who have had to design propellers for slow-speed motor boats. The six cylinders are 15¾ inches diameter by 23½

inches stroke. Air, fuel, exhaust and starting valves are arranged in the ordinary way, but are driven by a new arrangement permitting the engine to be reversed. There are two camshafts, one for ahead and one for astern motion, running in bearings which are fitted in the arms of V-shaped brackets. These V brackets can rotate around the center of a reversing shaft which corresponds to the tip of the V. Thus by rotating the reversing shaft the ahead or astern camshaft is brought in position to actuate the valve levers. The spur wheels, keyed on the camshafts, are both driven continuously by one pinion, which is fitted on a small two-crank shaft, which in its turn is rotated by two eccentric rods from the main shafting. The other details of the engine follow the usual Diesel engine practice. Each cylinder has two fuel pumps—one for injecting the oil, the other being a spare one. The air compressor, the cooling water pump and the bilge pumps are situated at the back of the engine. The front of the engine shows the hand-wheel for rotating the reversing shaft and the handles controlling the admission of fuel and compressed air. Here, again, the marine engineer will feel quite at home. A separate 50-horsepower Diesel engine drives the air compressor for filling the air tanks, while a 10-horsepower kerosene (paraffin) motor drives the electric generator for lighting the ship. These are the only auxiliaries.



GENERAL ARRANGEMENT PLANS OF THE VULCANUS

Troubles and Results

A rather complete account of the troubles and experiences during the first voyages of the *Vulcanus* was given at the April meeting of the Institution of Naval Architects by Mr. C. Kloos, constructing manager of the Werkspoor Works. It may be repeated here:

"On the first voyage from Rotterdam to Hamburg and back a slight trouble was experienced with the air pumps, which could be remedied easily. During the second voyage to Aranton an air pump lever snapped owing to the extra strains put on it by water coming down the funnel during a heavy gale. When stronger levers were made no trouble was experienced from this source. There was also trouble with some piston rings "sticking" as a consequence of incomplete combustion. This was caused by a gauze wire covering the air in-take pipe, which was choked and prevented the entry of sufficient air. After the third voyage some minor alterations were made, but overhauling was found unnecessary. Since then the *Vulcanus* has remained in regular service and made many voyages on the Baltic, Mediterranean and Black seas."

Fuel Consumption

Concerning fuel consumption the owners gave the following account of a voyage to Sweden:

Rotterdam to Stockholm—Cargo, 1,000 tons gasoline (petrol); distance, 735 miles; duration, 100 hours; consumption, 7,390 kg. crude oil; consumption per 100 miles, 1 ton crude oil.

Stockholm to Rotterdam—Cargo, 500 tons water ballast; distance, 735 miles; duration, 98 hours; consumption, 16,100 pounds crude oil; consumption per 100 miles, 1 ton crude oil; fuel costs for 100 miles with 1,000 tons cargo, $10.50-$12.00 (£2 3s. to £2 10s.).

This confirms the Werkspoor statement that in ordinary practice the transport of 1,000 tons of cargo does not cost more than $12.00 (£2. 10s.).

AUXILIARY SCHOONER SAN ANTONIO, FITTED WITH A NON-REVERSING DIESEL MOTOR

PROSPECTS

These results speak for themselves. A still more reliable test of these engines is given by the order book of the Werkspoor Works. It gives unmistakable evidence of the trust put in these engines by the owners of the *Vulcanus* and by others who watched its proceedings.

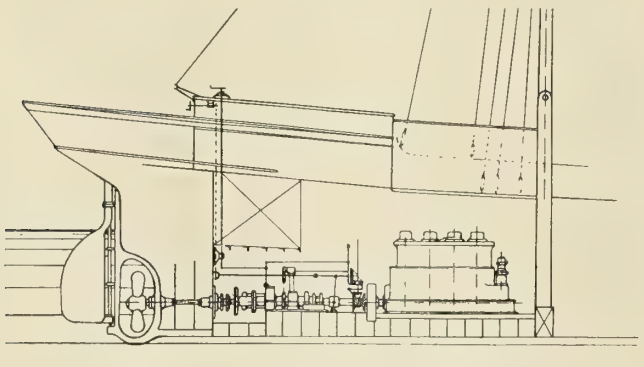
The following ships were, or are to be, equipped with Werkspoor Diesel engines:

Vulcanus—Owners, Anglo Saxon Oil Co.; dimensions, 196′ 0″ x 37′ 9″ x 13′ 2½″ x 7′ 6″ draft; 1,900 tons displacement; engines, 6-cylinder, 15¾″ x 23½″, 500 H. P. at 165 revolutions, 8½ knots.

San Antonio—Owners, S. Hammerstein, Rotterdam; dimensions, 154′ 0″ x 26′ 10″ x 12′ 3″ x 11′ 5″ draft; 500 tons displacement; engine, non-reversible, 4 cylinder, 200 H. P. at 180 revolutions (auxiliary).

Cornelis—Dimensions, 154′ 0″ x 26′ 10″ x 12′ 5″ x 10′ 8″ draft; engine, 4-cylinder, 200 H. P. at 180 revolutions.

Sembilan—Owners, Royal Packet Line, Amsterdam; dimensions, 152′ 0″ x 26′ 0″ x 9′ 6″ x 7′ 0″ draft.



SECTION OF ENGINE ROOM OF THE SAN ANTONIO

Building—Owners, Anglo Saxon Oil Co.; dimensions, 258′ 0″ x 48′ 0″ x 19′ 8″ x 18′ 6″ draft; 4,250 tons displacement; engine, 6-cylinder, 1,100 H. P. at 175 revolutions.

Building—Owners, S. A. d'Armement et de Commerce, Antwerp; dimensions, 375′ 0″ x 51′ 0″ x 29′ 0″ x 23′ 0″ draft; 9,300 tons displacement; engines, twin screw, 2 x 6 cylinders, 2 x 1,100 H. P. at 170 revolutions; 8½ knots.

Moreover, it is said that a well-known line of steamers is about to order three twin-screw ships of from 2,000 to 1,100 horsepower each.

NON-REVERSING TYPE

Besides reversible Diesel engines the Werkspoor Works is building smaller non-reversing motors as auxiliaries for sailing vessels. This type is built from 160 to 400 brake-horsepower, and is fitted invariably with a reversible screw propeller. The power wanted for changing the position of the blades is given by the engine itself, and a clutch is provided if desired. The working of the clutch is performed by hand; both clutch and propeller blade mechanism can be worked from deck or in the engine room. When no clutch is fitted it is sometimes difficult to steer the ship when the angle of the blades is zero. An arrangement is therefore made allowing the number of revolutions to be cut down to one-half.

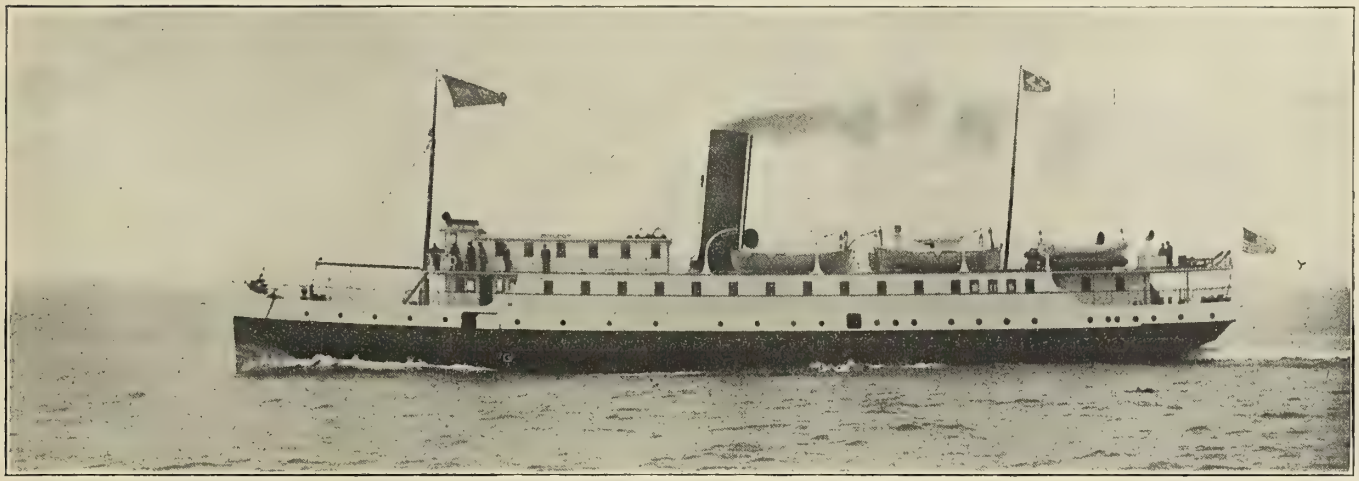
The engines are four-cylinder, four-cycle box frame motors. The working speed is controlled by a governor, but at the moment the position of the blades is changed the admission of fuel to the engine can be throttled by hand also. The bilge and ballast pumps are driven from an intermediate shaft geared from the main crank-shaft. An auxiliary air compressor is driven by a small kerosene (paraffin) motor, which can be started by hand. The following table shows the sizes:

FOUR-CYLINDER MARINE DIESEL ENGINES. PROPELLERS WITH REVERSING BLADES.

B. H. P.	Revolutions.	Weight A.		Weight B.		Total Weight.	
		Tons	Cwt.	Tons	Cwt.	Tons	Cwt.
100	270	11	16	3	10	15	6
130	260	15	..	3	18	18	18
160	250	19	4	4	4	23	8
200	240	24	..	4	16	28	16
250	230	30	10	5	8	35	18
325	220	40	10	6	4	46	14
400	210	51	..	7	2	58	2

Weight A includes: Engine, ballast, bilge and cooling water pumps and air vessels.
Weight B includes: Reversing mechanism, propeller and shaft.

The first ship fitted with this type of engine is the *San Antonio*, a three-masted schooner (see the above table from order book), which has given a good account of herself on a voyage to Brazil and return, when the engine was in operation constantly.



NEW PASSENGER STEAMER SOL DUC

The Sol Duc

The steamship *Sol Duc*, recently built by the Seattle Construction & Dry Dock Company, Seattle, Wash., for the Inland Navigation Company, is one of the finest vessels owned by this company. It is expected that the vessel will play an important part in carrying tourists to the several pleasure resorts on Olympic Peninsula, the most important of which is Sol Duc Springs, where a palatial hotel has just been completed.

Accommodations are provided on the *Sol Duc* for about 163 passengers in forty-nine staterooms, and there is a freight capacity of 14,000 cubic feet on the main deck.

The hull is built of mild steel, and has five watertight bulkheads extending to the main deck. Following are the principal hull dimensions:

Length over all	205 feet.
Length between perpendiculars	195 feet.
Breadth, molded	32 feet.
Mean draft (on trial trip)	9 feet 9¼ inches.
Displacement (on trial trip)	795 tons.

There are four decks, all laid of wood, viz.: the boat, upper, main and lower decks. On the boat deck are located the pilot house, the captain's quarters, the mate's quarters, ten staterooms, the wireless operator's cabin and quarters, and the lifeboats and rafts. Directly below on the upper deck there is an observation room forward, twenty-nine staterooms amidships and a social hall aft. The galley, the engineer's quarters, the chief steward's quarters, ten staterooms and cargo space occupy the entire space on the main deck, while the dining saloon, pantry and storeroom are on the lower deck aft. Forward of the machinery space on this deck are the bar and smoking room and the crew's quarters.

Steam for the propelling and auxiliary machinery is supplied by two Ballin watertube boilers of 5,000 square feet total heating surface. These boilers are fitted with Staples & Pfeiffer burners and burn oil fuel under natural draft.

The main engine has cylinders 17 inches, 28 inches and 47½ inches diameter by 36 inches stroke. The propeller is 11 feet in diameter by 15 feet 6 inches pitch. The condenser is of the indpendent type, and has a cooling surface of 1914 square feet. A 10-inch centrifugal circulating pump, of the Seattle Construction & Dry Dock Company's make, supplies cooling water for the condenser. The air pump is attached to the main engine.

The following auxiliaries were installed:

Two vertical duplex main feed pumps, made by M. T. Davidson Company.

One horizontal duplex fire and bilge pump, made by George F. Blake Manufacturing Company.

One horizontal duplex sanitary pump, male by George F. Blake Manufacturing Company.

One horizontal duplex fresh water pump, made by George F. Blake Manufacturing Company.

Two horizontal duplex oil fuel pumps, made by Fairbanks, Morse & Company.

One Reilly multi-coil feed-water heater.

One 7-kilowatt, direct-current Westinghouse generator set.

One 20-kilowatt, direct-current Westinghouse generating set.

The oil fuel compartments have a capacity of 1,200 barrels.

The average results of the speed trial on the measured mile off Vashon Island were as follows:

Speed, knots	15.37
Revolutions per minute	120
Boiler pressure, pounds	215
Steam pressure at high-pressure receiver, pounds	208
Steam pressure at intermediate-pressure receiver, pounds	76
Steam pressure at low-pressure receiver, pounds	13.5
Vacuum, inches	25.2
Indicated horsepower	1,515
Slip of propeller, percent	16.34
Revolutions per minute of circulating pump engine	216

On the trial trip, in addition to the standardization runs, an endurance run of four hours was made, and the performance of the vessel was very satisfactory.

Final Reports of Titanic Inquiries in America and England

Although considerable time has elapsed since the final report of the *Titanic* investigation in America was made public, we have withheld publication of the conclusions of this inquiry until the subsequent investigation in England had been completed, so that the recommendations of both could be compared and any further information brought out in the latter which might have some bearing on these recommendations could be included. While the report from the British inquiry is by far the longer document, covering every phase of the disaster, it contains little information that would contradict or add materially to the facts brought out in the American investigation, except that in England the builders of the vessel were at hand, and a thorough examination of the disaster from a professional standpoint could be carried out and a better knowledge of the extent of the damage to the vessel and the consequent behavior of the vessel could be determined which was not possible in America.

The American inquiry was conducted by the United States Senate Committee on Commerce, Mr. William Alden Smith, of Michigan, chairman. The recommendations contained in its report are as follows:

Recommendations of United States Committee

The committee finds that this accident clearly indicates the necessity of additional legislation to secure safety of life at sea.

By statute the United States accepts reciprocally the inspection certificates of foreign countries having inspection laws approximating those of the United States. Unless there is early revision of inspection laws of foreign countries along the lines laid down hereinafter, the committee deems it proper that such reciprocal arrangements be terminated, and that no vessel shall be licensed to carry passengers from ports of the United States until all regulations and requirements of the laws of the United States have been fully complied with.

Lifeboats

The committee recommends that sections 4481 and 4488, Revised Statutes, be so amended as to definitely require sufficient lifeboats to accommodate every passenger and every member of the crew. That the importance of this feature is recognized by the steamship lines is indicated by the fact that on many lines steps are being taken to provide lifeboat capacity for every person on board, including crew, and the fact of such equipment is being widely advertised. The president of the International Mercantile Marine Company, Mr. Ismay, definitely stated to the committee (p. 985):

"We have issued instructions that none of the ships of our lines shall leave any port carrying more passengers and crew than they have capacity for in the life-boats.

"Not less than four members of the crew, skilled in handling boats, should be assigned to every boat. All members of the crew assigned to lifeboats should be drilled in lowering and rowing the boats not less than twice each month, and the fact of such drill or practice should be noted in the log."

The committee recommends the assignment of passengers and crew to lifeboats before sailing; that occupants of certain groups of staterooms and the stewards of such groups of rooms be assigned to certain boats most conveniently located with reference to the rooms in question; the assignment of boats and the shortest route from stateroom to boat to be posted in every stateroom.

Searchlights

The committee recommends that every ocean steamship carrying 100 or more passengers be required to carry two electric searchlights.

Wireless

The committee finds that this catastrophe makes glaringly apparent the necessity for regulation of radio-telegraphy. There must be an operator on duty at all times, day and night, to insure the immediate receipt of all distress, warning or other important calls. Direct communication either by clear-speaking telephone, voice tube, or messenger must be provided between the wireless room and the bridge, so that the operator does not have to leave his station. There must be definite legislation to prevent interference by amateurs, and to secure secrecy of radiograms or wireless messages. There must be some source of auxiliary power, either storage battery or oil engine, to insure the operation of the wireless installation until the wireless room is submerged.

The committee recommends the early passage of Section 6412, already passed by the Senate and favorably reported by the House.

The committee recommends that the firing of rockets or candles on the high seas for any other purpose than as a signal of distress be made a misdemeanor.

Structural Requirements

The committee recommends that the following additional structural requirements be required as regards oceangoing passenger steamers the construction of which is begun after this date:

All steel ocean and coastwise seagoing ships carrying 100 or more passengers should have a watertight skin inboard of the outside plating, extending not less than 10 percent of the load draft above the full-load waterline, either in the form of an inner bottom or of longitudinal watertight bulkheads, and this construction should extent from the forward collision bulkhead over not less than two-thirds of the length of the ship.

All steel ocean and coastwise seagoing ships carrying 100 or more passengers should have bulkheads so spaced that any two adjacent compartments of the ship may be flooded without destroying the flotability or stability of the ship. Watertight transverse bulkheads should extend from side to side of the ship, attaching to the outside shell. The transverse bulkheads forward and abaft of the machinery spaces should be continued watertight vertically to the uppermost continuous structural deck. The uppermost continuous structural deck should be fitted watertight. Bulkheads within the limits of the machinery spaces should extend not less than 25 percent of the draft of the ship above the load waterline and should end at a watertight deck. All watertight bulkheads and decks should be proportioned to withstand, without material permanent deflection, a water pressure equal to 5 feet more than the full height of the bulkhead. Bulkheads of novel dimensions or scantlings should be tested by being subjected to actual water pressure.

The British court appointed to investigate the *Titanic* disaster was headed by Lord Mersey. Its recommendations are as follows:

Recommendations of British Court

The following recommendations are made. They refer to foreign-going passenger and emigrant steamships:

Watertight Subdivision

1. That the newly-appointed bulkhead committee should inquire and report, among other matters, on the desirability and practicability of providing ships with (*a*) a double skin carried up above the waterline; or, as an alternative, with (*b*) a longitudinal, vertical, watertight bulkhead on each side of the ship, extending as far forward and aft as convenient; or

(*c*) with a combination of (*a*) and (*b*). Any one of the three, (*a*), (*b*) and (*c*), to be in addition to watertight transverse bulkheads.

2. That the committee should also inquire and report as to the desirability and practicability of fitting ships with (*a*) a deck or decks at a convenient distance or distances above the waterline, which shall be watertight throughout a part or the whole of the ship's length; and should, in this connection, report upon (*b*) the means by which the necessary openings in such deck or decks should be made watertight, whether by watertight doors or watertight trunks, or by any other and what means.

3. That the committee should consider and report generally on the practicability of increasing the protection given by subdivision; the object being to secure that the ship shall remain afloat with the greatest practicable proportion of her length in free communication with the sea.

4. That when the committee has reported upon the matters before mentioned, the Board of Trade should take the report into their consideration, and to the extent to which they approve of it, should seek statutory powers to enforce it in all newly-built ships, but with a discretion to relax the requirements in special cases where it may seem right to them to do so.

5. That the Board of Trade should be empowered by the Legislature to require the production of the designs and specifications of all ships in their early stages of construction, and to direct such amendments of the same as may be thought necessary and practicable for the safety of life at sea in ships. (This should apply to all passenger-carrying ships.)

Lifeboats and Rafts

6. That the provision of lifeboat and raft accommodation on board such ships should be based on the number of persons intended to be carried in the ship, and not upon tonnage.

7. That the question of such accommodation should be treated independently of the question of the subdivision of the ship into watertight compartments. (This involves the abolition of Rule 12 of the Life-Saving Appliances Rules of 1902.)

8. That the accommodation should be sufficient for all persons on board, with, however, the qualification that in special cases, where, in the opinion of the Board of Trade, such provision is impracticable, the requirements may be modified as the board may think right. (In order to give effect to this recommendation, changes may be necessary in the sizes and types of boats to be carried and in the method of stowing and floating them. It may also be necessary to set apart one or more of the boat decks exclusively for carrying boats and drilling the crew, and to consider the distribution of decks in relation to the passengers' quarters. These, however, are matters of detail, to be settled with reference to the particular circumstance affecting the ship.)

9. That all boats should be fitted with a protective, continuous fender, to lessen the risk of damage when being lowered in a seaway.

10. That the Board of Trade should be empowered to direct that one or more of the boats be fitted with some form of mechanical propulsion.

11. That there should be a Board of Trade regulation requiring all boat equipment (under Sections 5 and 6, page 15, of the Rules, dated February, 1902, made by the Board of Trade under Section 427, Merchant Shipping Act, 1894) to be in the boats as soon as the ship leaves harbor. The sections quoted above should be amended so as to provide also that all boats and rafts should carry lamps and pyrotechnic lights for purposes of signaling. All boats should be provided with compasses and provisions, and should be very distinctly marked in such a way as to indicate plainly the number of adult persons each boat can carry when being lowered.

12. That the Board of Trade inspection of boats and life-saving appliances should be of a more searching character than hitherto.

Manning the Boats and Boat Drills

13. That in cases where the deck hands are not sufficient to man the boats enough other members of the crew should be men trained in boat work to make up the deficiency. These men should be required to pass a test in boat work.

14. That in view of the necessity of having on board men trained in boat work, steps should be taken to encourage the training of boys for the merchant service.

15. That the operation of Section 115 and Section 134 (*a*) of the Merchant Shipping Act, 1894, should be examined, with view to amending the same so as to secure greater continuity of service than hitherto.

16. That the men who are to man the boats should have more frequent drills than hitherto. That in all ships a boat drill, a fire drill, and a watertight-door drill should be held as soon as possible after leaving the original port of departure and at convenient intervals of not less than once a week during the voyage. Such drills to be recorded in the official log.

17. That the Board of Trade should be satisfied in each case before the ship leaves port that a scheme has been devised and communicated to each officer of the ship for securing an efficient working of the boats.

General

18. That every man taking a lookout in such ships should undergo a sight test at reasonable intervals.

19. That in all such ships a police system should be organized, so as to secure obedience to orders and proper control and guidance of all on board in times of emergency.

20. That in all such ships there should be an installation of wireless telegraphy, and that such installation should be worked with a sufficient number of trained operators to secure a continuous service by night and day. In this connection regard should be had to the resolutions of the International Conference on Wireless Telegraphy, recently held under the presidency of Sir H. Babington Smith. That where practicable a silent chamber for "receiving" messages should form part of the installation.

21. That instructions should be given in all steamship companies' regulations that when ice is reported in or near the track the ship should proceed in the dark hours at a moderate speed, or alter her course so as to go well clear of the danger zone.

22. That the attention of masters of vessels should be drawn by the Board of Trade to the effect that under the Maritime Conventions Act, 1911, it is a misdemeanor not to go to the relief of a vessel in distress when possible to do so.

23. That the same protection as to the safety of life in the event of casualty which is afforded to emigrant ships by means of supervision and inspection should be extended to all foreign-going passenger ships.

24. That (unless already done) steps should be taken to call an International Conference to consider, and as far as possible to agree upon, a common line of conduct in respect of: (*a*) The subdivision of ships; (*b*) the provision and working of life-saving appliances; (*c*) the installation of wireless telegraphy, and the method of working the same; (*d*) the reduction of speed or the alteration of course in the vicinity of ice, and (*e*) the use of searchlights.

On account of the information given by the builders of the *Titanic*, and the discussion of the technical features of the accident by other professional authorities the following account of the extent of the damage done to the ship by the collision and its effect upon the buoyancy of the vessel, given in

Lord Mersey's report, will be of interest to all shipbuilders and naval architects:

EXTENT OF THE DAMAGE TO THE SHIP

The collision with the iceberg, which took place at 11:40 P. M., caused damage to the bottom of the starboard side of the vessel at about 10 feet above the level of the keel, but there was no damage above this height. There was damage in the fore peak, No. 1 hold, No. 2 hold, No. 3 hold, No. 6 boiler room (the furthest forward), No. 5 boiler room. The damage extended over a length of about 300 feet.

As the ship was moving at over 20 knots she would have passed through 300 feet in less than ten seconds, so that the damage was done in about this time.

THE FLOODING IN FIRST TEN MINUTES

At first it is desirable to consider what happened in the first ten minutes. The fore peak was not flooded above the orlop deck, i. *e.*, the peak tank top, from the hole in the bottom of the peak tank. In No. 1 hold there was 7 feet of water. In No. 2 hold, five minutes after the collision, water was seen rushing in at the bottom of the firemen's passage on the starboard side, so that the ship's side was damaged abaft of bulkhead B sufficiently to open the side of the firemen's passage, which was 3½ feet from the outer skin of the ship, thereby flooding both the hold and the passage.

In No. 3 hold the mail room was filled soon after the collision. The floor of the mail room is 24 feet above the keel.

In No. 6 boiler room, when the collision took place, water at once poured in at about 2 feet above the stokehold plates on the starboard side at the after end of the boiler room. Some of the firemen immediately went through the watertight door opening to No. 5 boiler room, because the water was flooding the place. The watertight doors in the engine room were shut from the bridge almost immediately after the collision. Ten minutes later it was found that there was water to the height of 8 feet above the double bottom in No. 6 boiler room.

No. 5 boiler room was damaged at the ship's side in the starboard forward bunker at a distance of 2 feet above the stokehold plates at 2 feet from the watertight bulkhead between Nos. 5 and 6 boiler rooms. Water poured in at that place as it would from an ordinary fire hose. At the time of the collision this bunker had no coal in it. The bunker door was closed when water was seen to be entering the ship.

In No. 4 boiler room there was no indication of any damage at the early stages of the sinking.

GRADUAL EFFECT OF THE DAMAGE

It will thus be seen that all the six compartments forward of No. 4 boiler room were open to the sea by damage which existed at about 10 feet above the keel. At ten minutes after the collision the water seems to have risen to about 14 feet above the keel in all these compartments except No. 5 boiler room. After the first ten minutes the water rose steadily in all these six compartments. The fore peak above the peak tank was not filled until an hour after the collision, when the vessel's bow was submerged to above C deck. (The decks are numbered from A down to G, A being the deck immediately below the boat deck and G the one just above the orlop deck.) The water then flowed in from the top through the deck scuttle forward of the collision bulkhead. It was by this scuttle that access was obtained to all the decks below C down to the peak-tank top on the orlop deck.

At 12 o'clock water was coming up in No. 1 hatch. It was getting into the firemen's quarters and driving the firemen out. It was rushing round No. 1 hatch on G deck, and coming mostly from the starboard side, so that in twenty minutes the water had risen above G deck in No. 1 hold. In No. 2 hold, about forty minutes after the collision, the water was coming into the seamen's quarters on E deck through a burst fore-and-aft wooden bulkhead of a third class cabin opposite the seamen's wash place. Thus the water had risen in No. 2 hold to about 3 feet above E deck in forty minutes.

In No. 3 hold the mail room was afloat about twenty minutes after the collision. The bottom of the mail room, which is on the orlop deck, is 24 feet above the keel. The watertight doors on F deck, at the fore and after ends of No. 3 compartment, were not closed then. The mail room was filling, and water was within 2 feet of G deck, rising fast, when the order was given to clear the boats. There was then no water on F deck.

There is a stairway on the port side on G deck which leads down to the first class baggage-room on the orlop deck immediately below. There was water in this baggage-room twenty-five minutes after the collision. Half an hour after the collision water was up to G deck in the mail room. Thus the water had risen in this compartment to within 2 feet of G deck in twenty minutes, and above G deck in twenty-five to thirty minutes.

No. 6 boiler room was abandoned by the men almost immediately after the collision. Ten minutes later the water had risen to 8 feet above the top of the double bottom, and probably reached the top of the bulkhead at the after end of the compartment, at the level of E deck, in about one hour after the collision.

In No. 5 boiler room there was no water above the stokehold plates until a rush of water came through the pass between the boilers from the forward end, and drove the leading stoker out.

It has already been shown in the description of what happened in the first ten minutes that water was coming into No. 5 boiler room in the forward starboard bunker at 2 feet above the plates in a stream about the size of a deck hose. The door in this bunker had been dropped probably when water was first discovered, which was a few minutes after the collision. This would cause the water to be retained in the bunker until it rose high enough to burst the door, which was weaker than the bunker bulkhead. This happened about an hour after the collision.

One hour and forty minutes after the collision water was coming in forward in No. 4 boiler room from underneath the floor in the forward part in small quantities. The men remained in that stokehold till ordered on deck.

When the men left No. 4 some of them went through Nos. 3, 2 and and 1 boiler rooms into the reciprocating-engine room, and from there on deck. There was no water in the boiler rooms abaft No. 4 one hour and forty minutes after the collision (1:20 A. M.), and there was then none in the reciprocating and turbine-engine rooms.

There was no damage to the electrical engine room and tunnels.

From the foregoing it follows that there was no damage abaft No. 4 boiler room.

All the watertight doors aft of the main engine room were opened after the collision.

Half an hour after the collision the watertight doors from the engine room to the stokehold were opened as far forward as they could be to No. 4 boiler room.

FINAL EFFECT OF THE DAMAGE

The later stages of the sinking cannot be stated with any precision, owing to a confusion of the times, which was natural under the circumstances.

The forecastle deck was not under water at 1:35 A. M. Distress signals were fired until two hours after the collision (1:45 A. M.). At this time the fore deck was under water.

The forecastle head was not then submerged, though it was getting close down to the water about half an hour before the ship disappeared (1:50 A. M.).

When the last boat, lowered from davits D, left the ship, A deck was under water, and water came up the stairway under the boat deck almost immediately afterwards. After this the other collapsible boat, which had been stowed on the officers' house, was uncovered, the lashings cut adrift, and she was swung round over the edge of the coamings of the deck house onto the boat deck. Very shortly afterwards the vessel, according to Mr. Lightoller's account, seemed to take a dive, and he just walked into the water. When he came to the surface all the funnels were above the water.

The stern was gradually rising out of the water, and the propellers were clear of the water. The ship did not break in two, and she did eventually attain the perpendicular, when the second funnel from aft about reached the water. There were no lights burning then, though they kept alight practically until the last.

Before reaching the perpendicular, when at an angle of 50 or 60 degrees, there was a rumbling sound, which may be attributed to the boilers leaving their beds and crashing down onto or through the bulkheads. She became more perpendicular, and finally absolutely perpendicular, when she went slowly down. After sinking as far as the after part of the boat deck she went down more quickly. The ship disappeared at 2:20 A. M.

Observations

I am advised that the *Titanic* as constructed could not have remained afloat long with such damage as she received. Her bulkheads were spaced to enable her to remain afloat with any two compartments in communication with the sea. She had a sufficient margin of safety with any two of the compartments flooded which were actually damaged. In fact, any three of the four forward compartments could have been flooded by the damage received without sinking the ship to the top of her bulkheads. Even if the four forward compartments had been flooded the water would not have got into any of the compartments abaft of them, though it would have been above the top of some of the forward bulkheads. But the ship, even with these four compartments flooded, would have remained afloat. But she could not remain afloat with the four forward compartments and the forward boiler room (No. 6) also flooded. The flooding of these five compartments alone would have sunk the ship sufficiently deeply to have caused the water to rise above the bulkhead at the after end of the forward boiler room (No. 6) and to flow over into the next boiler room (No. 5), and to fill it up until in turn its after bulkhead would be overwhelmed, and the water would thereby flow over and fill No. 4 boiler room, and so on in succession to the other boiler rooms, till the ship would ultimately fill and sink.

It has been shown that water came into the five forward compartments to a height of about 14 feet above the keel in the first ten minutes. This was at a rate of inflow with which the ship's pumps could not possibly have coped, so that the damage done to these five compartments alone inevitably sealed the doom of the ship.

The damage done in the boiler rooms Nos. 5 and 4 was too slight to have hastened appreciably the sinking of the ship, for it was given in evidence that no considerable amount of water was in either of these compartments for an hour after the collision. The rate at which water came into No. 6 boiler room makes it highly probable that the compartment was filled in not more than hour, after which the flow over the top of the bulkhead between 5 and 6 began, and continued until No. 5 was filled. It was shown that the leak in No. 5 boiler room was only about equal to the flow of a deck hose pipe about 3 inches in diameter. The leak in No. 4, supposing that there was one, was only enough to admit about 3 feet of water in that compartment in one hour and forty minutes. Hence the leaks in Nos. 4 and 5 boiler rooms did not appreciably hasten the sinking of the vessel.

The evidence is very doubtful as to No. 4 being damaged. The pumps were being worked in No. 5 soon after the collision. The 10-inch leather special suction pipe which was carried from aft is more likely to have been carried for use in No. 5 than No. 4, because the doors were ordered to be opened probably soon after the collision when water was known to be coming into No. 5. There is no evidence that the pumps were being worked in No. 4.

The only evidence possibly favorable to the view that the pipe was required for No. 4, and not for No. 5, is that of Scott, a greaser, who says that he saw engineers dragging the suction pipe along one hour after the collision. But even as late as this it may have been wanted for No. 5 only.

The importance of the question of the damage to No. 5 is small, because the ship, as actually constructed, was doomed as soon as the water in No. 6 boiler room, and all compartments forward of it, entered in the quantities it actually did. It is only of importance in dealing with the question of what would have happened to the ship had she been more completely subdivided. It was stated in evidence that if No. 4 had not been damaged, or had only been damaged to an extent within the powers of the pumps to keep under, then, if the bulkheads had been carried to C deck, the ship might have been saved. Further methods of increased subdivision and their effect upon the fate of the ship are discussed later.

Evidence was given showing that after the watertight doors in the engine and boiler rooms had been all closed, except those forward of No. 4 group of boilers, they were opened again, and there is no evidence to show that they were again closed. Though it is probable that the engineers who remained below would have closed these doors as the water rose in the compartments, yet it was not necessary for them to do this, as each door had an automatic closing arrangement, which would have come into operation immediately a small amount of water came through the door. It is probable, however, that the life of the ship would have been lengthened somewhat if these doors had been left open, for the water would have flowed through them to the after part of the ship, and the rate of flow of water into the ship would have been for a time reduced, as the bow might have been kept up a little by the water which flowed aft.

It is thus seen that the efficiency of the automatic arrangements for the closing of the watertight doors, which was questioned during the inquiry, had no important bearing on the question of hastening the sinking of the ship, except that, in the case of the doors not having been closed by the engineers, it might have retarded the sinking of the ship if they had not acted. The engineers would not have prevented the doors from closing unless they had been convinced that the ship was doomed. There is no evidence that they did prevent the doors from closing.

The engineers were applying the pumps when Barrett, leading stoker, left No. 5 boiler room. But even if they had succeeded in getting all the pumps in the ship to work they could not have saved the ship or prolonged her life to any appreciable extent.

Effect of Suggested Additional Subdivision Upon Flotation

Watertight Decks—It is in evidence that advantage might be obtained from the point of view of greater safety in having a watertight deck.

Without entering into the general question of the advantage of watertight decks for all ships, it is desirable to form an opinion in the case of the *Titanic* as to whether making the bulkhead deck watertight would have been an advantage

in the circumstances of the accident, or in case of accident to ships of this class.

I am advised that it is found that with all the compartments certainly known to have been flooded—viz., those forward of No. 4 boiler room—the ship would have remained afloat if the bulkhead deck had been a watertight deck. If, however, No. 4 boiler room had also been flooded, the ship would not have remained afloat unless, in addition to making the bulkhead deck watertight, the transverse bulkhead abaft of No. 4 boiler room had been carried up to D deck.

To make the bulkhead deck effectively watertight for this purpose it would have been necessary to carry watertight trunks round all the openings in the bulkhead deck up to C deck. It has been shown that with the bulkhead abaft No. 5 boiler room carried to C deck the ship would have remained afloat if the compartments certainly known to have been damaged had been flooded.

I do not desire to express an opinion upon the question whether it would have conduced to safety in the case of the *Titanic* if a watertight deck had been fitted below the waterline, as there may be some objections to such a deck. There are many considerations involved, and I think that the matter should be dealt with by the bulkhead committee for ships in general.

Longitudinal Subdivision—The advantages and disadvantages of longitudinal subdivision by means of watertight bunker bulkheads were pointed out in evidence.

While not attempting to deal with this question generally for ships, I am advised that if the *Titanic* had been divided in the longitudinal method, instead of in the transverse method only, she would have been able, if damaged as supposed, to remain afloat, though with a list which could have been corrected by putting water ballast into suitable places.

This subject is one, however, which again involves many considerations, and I think that for ships generally the matter should be referred to the bulkhead committee for their consideration and report.

Extending Double Bottom up the Sides—It was shown in evidence that there would be increased protection in carrying the double bottom higher up the sides than was done in the *Titanic*, and that some of the boiler rooms would probably not then have been flooded, as water could not have entered the ship except in the double bottom. In the case of the *Titanic* I am advised that this would have been an advantage; but it was pointed out in evidence that there are certain disadvantages which in some ships may outweigh the advantages. In view of what has already been said about the possible advantages of longitudinal subdivision, it is unnecessary further to discuss the question of carrying up the double bottom in ships generally. This matter should also be dealt with by the bulkhead committee.

Watertight Doors—With reference to the question of the watertight doors of the ship, there does not appear to have been any appreciable effect upon the sinking of the ship caused by either shutting or not shutting the doors. There does not appear to have been any difficulty in working the watertight doors. They appear to have been shut in good time after the collision. But in other cases of damage in ships constructed like the *Titanic*, it is probable that the efficiency of the closing arrangement of the watertight doors may exert a vital influence on the safety of the ship. It has been represented that in future consideration should be given to the question "as to how far bulkheads should be solid bulkheads, and if there should be watertight doors, how far they may or may not be automatically operated?" This, again, is a question on which it is not necessary here to express any general opinion, for there are conflicting considerations which vary in individual cases. The matter, however, should come under the effective supervision of the Board of Trade much more than its seems to come at present, and should be referred to the bulkhead committee for their consideration, with a view to their suggesting in detail where doors should or should not be allowed, and the type of door which should be adopted in the different parts of ships.

The Graving Dock at Halifax, N. S.

BY E. A. SAUNDERS

Halifax has one of the finest graving docks on the Atlantic seaboard, and it is one which until very recently was also the largest. The dock was commenced in 1879 and was the better part of three years building. When the United States government were obliged to dock the battleship *Indiana*, it was found the Halifax dock was the only suitable one in which to place her, and Admiral Francis T. Bowles, who superintended the repairs, gave the following report:

"The Halifax dry dock is admirably located, in reference to the tidal current, for convenience for safety of vessels in entering and leaving the dock, and reflects much credit on those who planned this feature, so important when large and heavy vessels are to be handled in narrow limits. I have never seen such an altogether desirable arrangement.

"When the *Indiana* was docked, about an hour before high water, the tide gave 26 feet 6 inches over the sill and 28 feet 6 inches over the blocks, as set for that ship. The draft over the sill and length and breadth are ample to admit the largest warships afloat."

The dimensions of the dock are as follows:

	Feet
Length on top	600
Length on top keel blocks	560
Width of dock, coping level	102
Width available top keel blocks	79.2
Width of entrance, coping level	89.3
Width 17.3 feet below coping level	85
Depth of water on sill	30

In this dock the Hamburg-American steamer *Bremen*, 11,570 tons, was easily placed with her cargo and coal on board—a deadweight of 16,500 tons; this steamer with cargo is larger than any in the Canadian Atlantic trade to-day. When the dock was built it was considered sufficiently large to provide for the natural growth of steamers for a number of years, but the transatlantic traffic has grown so great during the past several years that vessels of very much increased size are now being planned, consequently the dock at this point is about to be increased sufficiently in size to accommodate them. In connection with the dock there is a first-class repair plant and several steamers have been practically rebuilt, viz., the *Ulunda, Universe, Knight Bachelor*, H. M. S. *Indefatigable* and others.

The dock is built of concrete and granite in a solid rock location, with spacious piers and deep water berths in connection. It is owned by the Halifax Graving Dock Company, Ltd., of London, and its original cost is said to have been in the neighborhood of $1,900,000 (£390,000); large sums have also been spent on the repair plant, which is a modern one in all respects.

The same company owns and operates a marine slip, situated on the Dartmouth side of the harbor, and used altogether for repairing and metalling ships up to 3,000 tons. In connection with the slip there are, in all, four tracks with six cradles, one with a capacity of 3,000 tons, one of 900 tons, two of 150 tons, and two of 100 tons, and as many as ten vessels have been repaired at once on these different cradles. This slip is also well equipped with a repair plant, which has been renewed from time to time, and is now a modern one in every particular.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Faults in Machinery Arrangements

It is proposed in the following notes to consider certain points in machinery arrangements from the point of view of the operating engineer. The majority of the points dealt with will no doubt appear obvious to the more experienced members of the profession who are in the habit of arranging machinery, but their repetition may be helpful to some of the more junior members.

First let us consider those defects which may cause loss of life or endanger the ship. Perhaps the commonest cause of accident is water-hammer, and steam connections must be carefully arranged to obviate the possibility of its occurrence. To this end steam pipes must never be arranged with dips or pockets in which water may lodge unless these points are efficiently drained, preferably by means of a steam trap. The pipes should have a continuous fall in one direction or another—the ideal arrangement being a fall from the boilers to a separator of ample capacity and a rise from the separator to the main engines. The separator should be fitted with a water gage and a connection from the bottom to a steam trap. A separate drain valve leading to the hot-well or feed tank is an advantage in case the steam trap "jibs," and some traps which depend on the action of a float are rather apt to stick when used on shipboard. Even points where only a very small amount of water may collect must be looked on with deep suspicion, as, when steam is turned on to a pipe line the effect of even the smallest quantity of water is to produce a partial vacuum, thus causing a rush of steam, which will project the water along the pipe with dangerous velocity.

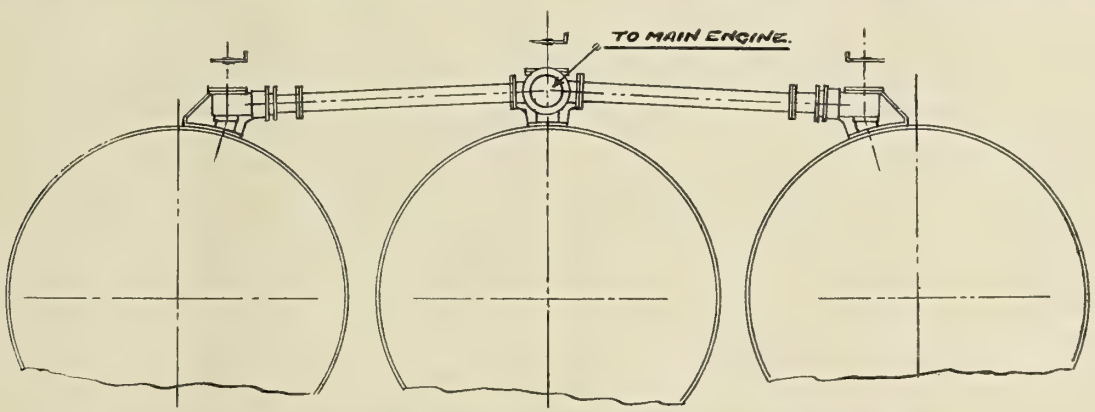
Where it is necessary to adopt an arrangement in which the steam pipes rise from the boilers, drain cocks must be fitted to the boiler stop valve chests above the valves. The lack of drain cocks in an arrangement of this type caused a serious accident in a case within the writer's experience.

The arrangement is indicated in the sketch. It will be seen that there were three boilers abreast, the pipes from the wing boilers rising to a gathering piece which formed the upper part of the stop valve chest of the center boiler, while the pipe to the main engines also rose from this point. The pipes were straight and of wrought iron, and were fitted with expansion joints as indicated, the whole being a very usual arrangement. The ship and machinery were quite new, being still in the builders' hands.

Preparatory to the basin or dock trial, steam was raised in the center boiler for warming-up purposes, and its stop valve opened. The port boiler was then fired up, and when sufficient pressure was showing its stop valve was also opened, and immediately the stop valve on the cold (starboard) boiler was blown to pieces.

The explanation of this is not far to seek. Water had collected over the port boiler stop valve, and when this valve was opened the plug of water was projected with great velocity along the pipe over the center boiler, bringing up against the starboard boiler stop valve, which it smashed to pieces.

Had the stop valve been opened very gradually, as it should have been, no trouble would have happened. In all such cases, however, drain cocks should be provided, and in addition should be so arranged that they can be got at without an acrobatic performance, otherwise it is unlikely they will ever be opened. Where it is possible the handle of the drain cock should be led up alongside that of the valve itself.



THE LACK OF DRAIN-COCKS CAUSED A SERIOUS ACCIDENT IN THIS ARRANGEMENT OF STEAM PIPES

Another common cause of accidents is insufficient provision for expansion in steam pipes where this provision takes the form of bends. There is no doubt that expansion bends, when properly designed, are preferable to expansion joints, but with large pipes these latter are very often a necessary evil. The writer has seen quite a number of jobs where the provision for expansion was so inadequate, the bends being so stiff, that the engineers were running very grave risks. Such cases are usually the work of small, unimportant firms who employ cheap and inexperienced men. Important firms of large experience are usually very particular on this point. The writer remembers being with a famous firm whose manager (a man of world-wide reputation), when shown an arrangement of steam pipes, invariably asked if it were not possible to put in larger or easier bends.

It is scarcely possible to lay down hard-and-fast rules on this subject; each case must be considered on its merits, and a few minutes of experiment with a piece of steel wire will do more to demonstrate the relative "springiness" of various arrangements than many pages of explanation. Try to get the expansion taken up by flexing a long "leg" of pipe, and remember that fine old engineering maxim, which says, "Better be sure than sorry," and don't forget that an inquiry or an inquest isn't good for a firm. See that the necks of valves or casings subject to bending stresses due to pipe

expansion are strong or well ribbed. These stresses are not easily estimated, so it is well to be on the safe side.

It may be added that the necessity of stout, well-ribbed necks applies very forcibly to boiler mountings. The writer is not likely to forget a case where the scum valve broke off in the hands of the engineer who was closing it. Note, also, that the flanges of mountings joining the boiler should be extra good and heavy, while the studs securing these flanges to the boiler shell should not be less than ¾ inch diameter for even the smallest fittings.

Where expansion joints have to be adopted in a steam pipe line, remember that they will only take up expansion in one direction. The writer has seen some instances where one expansion joint was expected to take up a sideway motion in addition to the movement in the proper direction. Now, an expansion joint is usually a nuisance at any time, but under these conditions, with the sleeve and packing pushed to one side, it is bound to be anything but a joy to the engineer. Don't forget to make adequate provision to take up the unbalanced thrust of the expansion joint. This load is equal to the product of the steam pressure and the sleeve area. Where a boiler stop valve forms one end of a steam pipe line fitted with an expansion joint, the stop valve neck should be reenforced with a good foot. If the unbalanced load is taken up on a bulkhead or other shipwork see that it is amply strengthened to resist it. Unless the pipe joining an expansion joint is very short and rigid, safety stays must be provided to prevent the possibility of its being blown out. It is not only in connection with steam pipes that freedom of movement is essential, for this requirement also applies to most pipe runs.

Although water pipes are not subject to much expansion, due to changes in temperature, where they are connected between bulkheads they are subject to the working of the ship, and must not be too rigid. Again, when connected to pumps or to the main engines the movement from these may in time fatigue a pipe which is too stiff. Of course, in these points judgment must be exercised, for it is evident that a small copper pipe is not under the same conditions as a cast iron one.

Another argument in favor of flexibility in pipe lines (and one which most sea-going men will endorse) is greater ease in making joints.

The necessity for strong necks on boiler mountings has already been emphasized; the same necessity applies also to the necks of sea valves joining the ship's skin, as in both cases a fracture of the neck below the valve would be a very serious matter and one not easily remedied. A case which illustrates this point occurred some years ago. The steamer *U*———, belonging to a well-known line, was in mid-ocean. The second engineer was on watch when he noticed that there appeared to be a considerable amount of water in the bilges. He accordingly put on the bilge pumps, but looking again some time after he was astonished to find that the water had risen considerably. Thinking that the pumps must be at fault he hurried up on deck, only to find that a good solid discharge was coming from the ship's side.

Finding the water to be still rising he started up the ballast pump and opened the special suction valve which puts this pump on to the bilges. Even this made no apparent impression, and being by this time considerably alarmed he called the chief, and when he arrived the floor plates were almost awash. As a last resort the main inlet valve was closed and the bilge-injection opened. This was effectual in lowering the water, when it was found that the neck of the main inlet valve was fractured, being only held in place by the pipe. Shores were obtained and wedged between the valve cover and the deck above, so as to close the opening as nearly as possible. A wooden box was next built around the valve, and filled with concrete made with broken firebrick. This made a good, sound job, which took the ship safely to port.

The mishap which came very near to causing the loss of the vessel (and which might easily explain more than one total disappearance) was probably in this case due to two causes. In the first place the neck of the sea valve might with advantage have been stronger, but probably the second reason advanced may have had a good deal to do with it. The pipe leading from the main inlet valve to the circulating pump (which was driven off the main engines) was dead straight. Again, the engines "worked" considerably, and it has been suggested that this movement, acting at the end of this straight pipe, caused a bending and twisting action on the neck of the inlet valve, which in time so fatigued it as to cause fracture.

Leaving now the consideration of some of the points affecting safety at sea it is proposed to deal with a few items in regard to machinery arrangements from the point of view of the sea-going engineer. A well-known professor of engineering of a North of England university (himself a practical man) used to strongly impress upon his students "the absolute necessity of so arranging machinery as to reduce to a minimum the inevitable profanity on the part of the operating engineer." In order to carry out this laudable object it is essential to consider each item from the point of view of the operating engineer and to enter into his joys and sorrows. This, of course, is only possible to the practical engineer, and no other should be allowed to arrange machinery.

The writer has been connected with several of the foremost marine engineering establishments in Great Britain, and in his experience the draftsmen who are responsible for the design and arrangement of the machinery are usually men who have been brought up with marine engines, who have served an apprenticeship in all the various shops, and who have, in addition, a technical college and often a university training. These men are highly trained specialists and have little to learn from any sea-going man. On the other hand, there are firms who will not pay to secure the services of efficient men, so that their reputations and the unfortunate engineers who have the running of their jobs at sea are bound to suffer.

Judging from letters which have appeared in these columns on the subject of faults in machinery design, there appears to be a certain amount of vagueness with reference to the person to be blamed. Thus one gentleman appeared to consider that the machinery builders should supply steam separators, exhaust steam heaters, grease extractors, etc., purely out of kindness of heart. Evidently he had never heard that marine machinery (in this country, at any rate) is built strictly to specification and in the face of very severe competition. That there were difficulties in the way of this free gift he evidently realized, for he writes, "You will never get it out of the drawing office." It is scarcely likely, unless this expensive auxiliary machinery is either specified or paid for.

As a matter of fact, the people who are primarily to blame are the shipowners themselves. They should employ an experienced superintendent engineer, who is in touch with all the special requirements and conditions which apply to his company's steamers. He should draw up his specification with special reference to these requirements, and see that his ideas, the result of his own experience, are embodied in the actual vessel. Secondly, the shipowners should pay a reasonable price and see that it is a firm with a reputation to lose who carries out the work.

To return to the subject. It is not possible to lay down hard-and-fast instructions in order to secure the ideal of minimum profanity mentioned above, but a few suggestions may be made. It must be remembered that there are other standpoints from which a design must be considered besides that

of the operating engineer, who is seldom in a position to appreciate all the conditions. On the other hand it is usually possible to produce a job which will satisfy all requirements and yet not turn the engineer gray-headed. Probably the most important consideration affecting the operating engineer is accessibility. See that every part that may require attention can be got at with the minimum amount of trouble. Thus in placing the boilers leave sufficient space at the backs for access to the combustion chamber stay ends, while all seams and rivet heads should be so placed, with regard to shipwork, that they can be readily calked. The writer has seen a butt-strap completely covered by an overhanging bunker-side, so that it was quite impossible to get near it.

Again, auxiliary engines should be arranged so that the necessary adjustments and overhauling can be readily carried out. Avoid placing auxiliary machinery too closely into a corner. The writer remembers having to get out the coils of an evaporator which was packed hard up into a corner of the engine room. The nipples securing the coils were behind, and he even yet longs intensely to say a few words to the man who arranged it in that position.

The operating gear for the main engines should be placed so that one man can work everything quite handily. Engines have come under the writer's notice with the reversing wheel on one column, the regulator valve wheel on another, and the throttle and starting levers on the other, while the drain cock handles were all over the place.

A most important point which does not always receive the attention it deserves is the arrangement of ladders and platforms. Ladders and platforms make up a quite inconsiderable fraction of the total cost of machinery, and a little extra attention in this direction means much to the operating engineer. In addition, the means provided for getting about usually impress a visitor to a ship as much as anything else, so that it is to the interests of the machinery builder to give some extra care to these points. See that the engine room entrance ladders have a good, easy rake, not steeper than 1 in 2 if possible, and avoid making the ladders in long lengths without landings.

Good space for overhauling should be provided on the top platform, which should be arranged at a convenient height for working at the cylinder covers. Try to get decent head room on the middle or packing platform, and avoid the necessity of crawling to get at the gear. See that every valve and cock in the ship can be got at in comfort, remembering that contortionist performances in a high temperature are not conducive to good temper. In this respect the stokehold is often somewhat neglected. Arrange the boiler stop valves so that they can be got at easily and quickly, and avoid placing them close under the uptakes. A good deal more attention might be paid to these matters with considerable advantage, for the writer has seen some boiler tops "arranged" so that the manipulation of the valves was a very good preparation for the engineer's future state. An example of how not to do it was the case of a certain vessel, where, in order to get at the gage-glass cocks, the unfortunate engineer had to fix a rope round the stop valve, put a loop in the end of the rope, and with his foot in the loop lower himself over the boiler crown. The writer also remembers as an apprentice helping to drag his mate from the boiler tops of a cross-channel steamer where he had fainted in his efforts to reach a pressure gage cock. It cannot be too strongly urged that careful attention should always be directed to the placing of the mountings on the boiler tops with reference to their accessibility.

See that every pipe joint can be readily got at, and never arrange pipes so that about half a dozen have to be removed to get at one. If a pipe trunk is fitted to take pipes through a cross bunker, see that it is of ample size for a man to get in and remake joints. The writer has come across pipe trunks where the joints could certainly be seen, but to remake them the bunker side would require to be taken out.

Under-floor pipes being out of sight are often neglected as to accessibility. If possible no pipe joint should be covered by another pipe, but every joint should be visible when the floor plates are removed. See that the strainers in the bilges at the suction ends of the bilge pipes are not covered up by pipes, etc., so that the job of clearing them is no worse than it otherwise would be.

In scheming out pipe systems and connections endeavor to make them as simple and fool-proof as possible. Don't arrange matters so that the engineer has to carry out some mental gymnastics to decide which valves are to be opened and which closed. A good deal can be done in this respect to save the engineer trouble. Thus take the case of a pump with several suctions. Don't place a valve here and a change cock somewhere else, but arrange the whole thing in one valve chest at the pump with nameplates to distinguish the suctions.

Again, suppose the auxiliary exhaust system is connected to the auxiliary condenser, to the main condenser and to the atmosphere, it is better to arrange one valve chest to control these and place it in a convenient position where changing over can be rapidly carried out than to have the valve for exhaust to auxiliary condenser in one corner of the engine room, that for the exhaust to atmosphere in another and the valve for exhaust to main condenser somewhere else. Numerous instances might be cited, many of which will doubtless occur to most sea-going men. BRITISHER.

Carels-Westgarth Marine Diesel-Engined Ship Eavestone

On July 22 the writer was present on the trial run of the Diesel-engined ship *Eavestone,* which is a 3,700-ton cargo ship fitted with a 1,000-horsepower, four-cylinder, two-cycle Carels marine engine. We made a start without any difficulty and spent a day on the North Sea maneuvering in every conceivable manner. There was no noise in the engine room, no vibration, no heat radiating from the engine, no smoke from the exhaust. It was very easy to reverse the engine from full speed ahead to full speed astern in eight seconds. We could vary the speed of the engine from its normal 100 revolutions per minute to 40 revolutions per minute in three seconds.

The engine is built on the lines of a marine steam engine. It actuates the scavenging pumps, the circulating water pumps and the bilge pumps from the cross-head by rocker arms. The engine behaved as if it had been in training for years, when, in fact, this was its first day's run, having been assembled in the ship without any testing in the shop of its builders, Messrs. Carels Bros., Ghent, Belgium. H. R. W.

Antwerp.

In Breakdown Time

That in breakdown time the marine engineer has very often to "fight" under adverse conditions is a truth too widely known to be reasserted again. And although it is true also that these conditions are steadily improving in this age of monster ocean liners, wireless telegraph and simplified machinery, yet 95 percent, if not more, of the operating marine engineers have to make repairs "using" more brains than hands, looking at the miserable resources that the limited space of the storeroom in a vessel carries and offers to him.

The following brief stories of breakdowns and their repairs will show better than a well-written article the truth of this statement.

Without a Tube Expander

A continuous trouble in a Scotch marine boiler, 6 feet in diameter and 9 feet long, fitted in a seagoing launch, was a

leakage through the joints connecting the tubes with the fire-box sheet.

The ship was out of commission, but with the machinery ready "to steam," when an order to get up steam as quickly as possible was received to relieve another vessel temporarily at her station; with the urgency of the order a tube expander could not be put on the list for provisional tools, and, furthermore, there were instructions to secure from the ship to be relieved the necessary tools as well as the supplies that might be needed.

After a 24-hour run we arrived at the station and relieved the vessel. It happens then that the tube expander aboard the latter was ¼ inch larger in diameter than that necessary

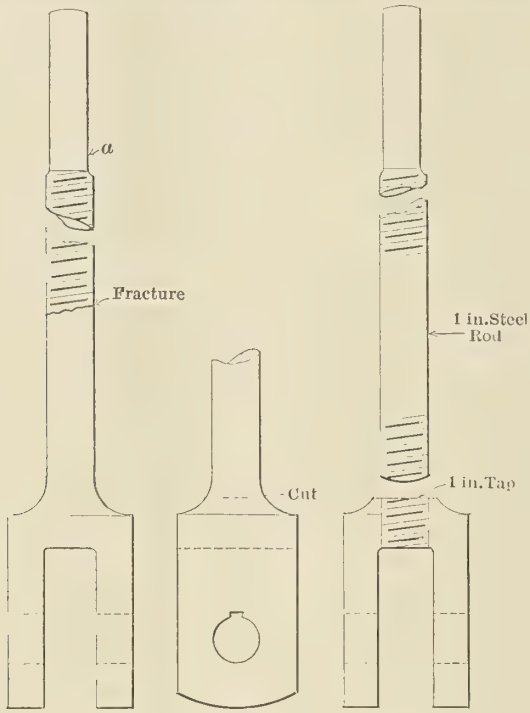


Fig. 1 Fig. 2 Fig. 3

for the relieving vessel, so we had to proceed on our voyage without an expander.

At the ending of the second trip several boiler tubes began to leak so badly that the steam pressure could not be kept at its working point. As soon as we arrived in port and blowed the steam off we found seven tubes leaking at their back ends. No tube expander could be found in the town, so one was asked by telegraph to the main office at Manila. It meant a couple of weeks of inertia, but in order to avoid discontinuance of the regular route on which the launch was running, and after a good deal of thinking, an idea of stopping the leakage temporarily was carried into practice as follows:

From a spare boiler tube several pieces or lengths of ring were cut out, each one measuring ⅝ inch wide (⅛ inch wider than the thickness of the fire-box plates). These rings were split so as to make their external diameter equal to that of the internal diameter of the tubes; one end of every ring was beveled a little so as to place them easily on the center of the mouth of every leaky tube.

Exerting some pressure, the rings were finally pulled inside the leaky tubes in such a way that we could see how the leakage was gradually stopping. Once the ferrules were in place the leakage quite totally disappeared. Of course, this was an emergency repair only, but we continued the route and made two round trips, after which the ferrules were removed and the tubes re-expanded.

As these tubes were somewhat old, and notwithstanding that great care was used in preventing sudden changes of temperature in them, they were frequently leaking. Nineteen months later, and as a result of so much re-expanding, five of the tubes became so thin (about one-third of the original thickness) at their back ends that the tube expander was too small. This gave us a hard time, and we were obliged to resort to the same scheme just described, *i. e.*, the fitting of iron rings or ferrules made from a spare tube, as reinforcement to the weak ends, and after fitted at the same location as before they were re-expanded. The idea proved again to be a good one, as the result was water and steam-tight joints, which lasted till the launch was subjected to a general repair.

Broken High-Pressure Valve Stem

The engine for which the boiler with leaky tubes above mentioned generated steam was of the compound-condensing type. Some four years ago, and while running at full speed ahead, the engine stopped suddenly.

We found the cause to be the high-pressure valve stem broken down in two pieces, the fracture being at the root of the threaded part (Fig. 1). There was not a spare valve stem, and the next port to which we were proceeding was at about a four hours' run. In order to reach it we decided to run with one engine. But a difficulty was met with in that the pumps were connected to the high-pressure wrist pin, and, moreover, the low-pressure valve stem was ⅛ inch larger in diameter than the broken one. Fortunately, the external diameter of both low and high-pressure valve rod bushings was the same, consequently after removing the broken stem and its bushings, the low-pressure valve, piston rings and connecting rod, and securing the piston on the top end of its stroke by means of a piece of wood beneath the cross-head slipper, the low-pressure valve rod, with its bushing, was removed and assembled to the high-pressure valve. Then the low-pressure valve receiver was covered and the hole plugged.

With 80 pounds gage pressure and at 90 revolutions per minute (100 pounds and 140 revolutions were the normal run), the two remaining ports were made; and having no telegraph office in the first port the mishap was wired from the last to the main office.

Wishing to continue the regular run under normal conditions as soon as possible and without waiting for the requested new stem, which might have taken one or two months before its arrival aboard the ship, and after reviewing the resources that the storeroom offered, as the town, like the majority of the Philippine ports, lacked both machine shops and hardware stores, the following idea was carried out:

From a steel octagonal bar of 5/16-inch sides, by filing, we got a round bar 1 inch in diameter; one of the ends to a length of about 6 inches was reduced to ¾ inch diameter to provide for the tail end at the top side (a, Fig. 1); the other end was tapped for about 1⅛ inches with 1-inch threads. From the broken spindle the fork end was sawed off (Fig. 2), and a hole was drilled vertically on the center, which was tapped afterward with a 1-inch tap (Fig. 3). The screwed end of the rod, which was of 1-inch diameter, was heated, screwed down to the fork, and finally riveted under this latter (Fig. 3). As the broken stem was ⅛ inch larger in diameter than the home-made one, we had to fix liners to the bushing and thus adjust it to the rod. Taking into consideration the pressure, this stem with the lined bushings was assembled to the low-pressure valve; and the final result was a satisfactory one, as was shown by a three months' run, after which a general overhauling was made on the machinery and a new stem fixed.

Philippine Islands. AUGUSTO SUZARA.

The United States Collier *Jupiter*, of 20,000 tons displacement, which is the largest ship built on the Pacific Coast, was launched Aug. 24 at the Mare Island navy yard. The vessel is noteworthy as the first electrically-driven ship ever constructed.

Review of Important Marine Articles in the Engineering Press

Heavy-Oil Engines.—A review of the second and third of a series of lectures by Captain Sankey before the Society of Arts describing heavy-oil engines. In these lectures the principal points were the consideration of the mechanical details of Diesel engines as compared with steam engines and the minor points of difference among the different makes of oil engines themselves. These last are very small and might be due either to the limited time the engines had been built or that a best type had already been evolved. One interesting point of design referred to was the large range of powers available in engines by the use of a few sizes of cylinders and the combination of these in from one to four or even more lines. The review indicates that the lectures were replete with data and figures on design and operation of these engines, and the original papers are probably a valuable contribution to the literature of the subject. Reference was made to fuels, the wide range of oils available and the composition best suited for use. 2,200 words.—*Engineering,* May 17.

The German Naval Architects.—The summer session of the Schiffbautechnische Gesellschaft was held June 4 to 9. The session was to a large degree under the auspices of the navy and included the witnessing of torpedo boat and other maneuvers and a visit to the Kaiser Wilhelm Canal. Four papers with the following authors and titles were read and discussed: *The Development of Submarine Boats and their Engines,* by Marinebaurat J. Berling, of Kiel; *On the Widening of the Kaiser Wilhelm Canal,* by Herr Regierungs und Baurat H. W. Schultz, of Kiel; *The Development of the Torpedo,* by Capitan zur See S. Michelsen, of Kiel; and *Diesel Motor Building at the Germaniawerst,* by Direktor C. Regenbogen. As a review of a review, this article can only barely mention the subjects of importance for shipbuilders. As to the first the submarine boat was considered in two types, the submersible and the submarine. It was assumed in both cases that the vessel had to be able to run at the surface as well as submerged. Therefore, sufficient reserve buoyancy was required to run safely on the surface and in such a way as to rapidly be reduced for diving. Further, provision had to be made for equalizing the weight and moments in the vessel due to suddenly firing a torpedo or slowly using fuel, water, or stores. All this had been done by carefully chosen reserve buoyancy tanks and aid tanks. Submersibles have more reserve buoyancy, better sea qualities, more comfortable quarters, and are safer in case of accident; on the other hand, the submerged speed of submarines is somewhat greater, being 9½ knots as compared to 9 knots for two ordinary specimens of the two types. The propeller is a compromise due to its wide range of service conditions. It has been proposed to build submersibles to 18 knots speed when on the surface and 11½ knots submerged. Attention was paid to four different types of propelling machinery: (1) electric storage batteries and electric motors and oil engines; (2) steam machinery; (3) steam engines with soda boilers; and (4) compressed air in nickel steel tanks, under water propulsion in this case being effected by oil engines. Examples of these types were described in some detail. The last paper read told the early development of the Diesel motor at the Krupp Germaniawerst. Its author then described a number of late designs, some illustrations of which were shown. The Krupps were pioneers in the development of some features of Diesel engine design and were making rapid pace in placing it in first place for usefulness to the marine engineer. The opinion was expressed that it was only a question of time until oil engines of the largest sizes would be acceptable and demanded by owners. The Krupp Co. has already turned out 69,434 brake horsepower of Diesel engines in 640 cylinders. 9,700 words. In two parts.—*The Engineer,* June 14, 21

The Ice-Breaking Steamer Pjotr Welikij.—A peculiar vessel for ice-breaking was designed and built last winter in Sweden. The dimensions of the boat are: Length over all, 182 feet 1 inch; maximum breadth, 50 feet 10 inches; molded depth, 27 feet 5 inches; draft, 21 feet 4 inches; displacement, 1,900 tons. The lines bear a slight resemblance to a yacht's, and, although of such large ratio of beam to length, on trial she exceeded the required speed of 12½ knots by 2 knots. The propelling machinery of the ship consists of four single-ended Scotch boilers 14 feet 6 inches in diameter and 8 feet long, worked under forced draft. The main engine has cylinders 22 7/16, 35 7/16, and 59 1/16 by 39⅜ inches stroke and a maximum designed horsepower of 2,500. Forward there is located a smaller engine with cylinders 15 15/16, 25⅝ and 41⅜ inches diameter, of 1,200 designed horsepower, driving a smaller screw through a Benn coupling which throws out the propeller automatically if a dangerously large piece of ice be struck. A notable feature of the hull is a number of large ballast and trimming tanks served by powerful pumps, by which the ship can be worked through very thick ice floes. Thorough tests have proven the ship entirely satisfactory. 780 words. Illustrated with photograph and drawings of general arrangement.—*Engineering,* June 7.

Icebergs and Their Location in Navigation.—An editorial review of a lecture upon this subject at the Royal Institution, by Dr. Howard T. Barnes, F. R. S., Professor of Physics at McGill University, Montreal. The ice-fields in the North Atlantic and the formations generally found were described. The particular subject treated was the temperature of sea water and many interesting results were presented. The usual methods of sea water temperature measurement being entirely inadequate, the speaker has devised a recording micro-thermometer which has proven quite satisfactory for the work. This instrument was placed in a survey boat of the Canadian Hydrographic Service and the contact points set for a reading at a depth of five feet. It was noted that upon approaching an iceberg the temperature slowly rose and then suddenly fell. This was found to be the invariable iceberg effect upon the instrument. Approaching land left its own characteristics upon the tape and other changes in subsurface conditions were easily recognized when once known. The lecture covered a field which may soon become very important, as more investigation brings results in lessened dangers to navigation. 1,700 words.—*Engineering,* June 7.

Ferro-Concrete Sludge-Pumping Pontoon; Manchester Ship Canal.—By W. Noble Twelvetrees, M. I. Mech. E. A description of a boat of novel construction for an unusual purpose. The structure is of ferro-concrete throughout, including decks and houses. Although not self-propelled, it contains a steam plant consisting of a Scotch boiler 13 feet 8 inches in diameter and 10 feet 6 inches long, a vertical compound engine, condenser, three centrifugal pumps and three steam windlasses. In the dredging of the Manchester Ship Canal, when the silt can be dumped onto nearby lands, their fertility is improved and a saving in towing charges is effected. This pontoon is to be moored at some point on the canal and the barges towed to it, when the dredged material is pumped out of the barge across the pontoon and onto the land. The article describes in some detail and shows clearly by drawings the construction of the pontoon. It is 100 feet long, 28 feet wide, and 8 feet

6 inches deep to main deck with a load draft of 6 feet 6 inches. It is divided transversely by four watertight bulkheads and longitudinally by two. Each compartment was tested for watertightness. The outer shell is 3 inches thick, except in way of boiler and bunker space, where it is 4 inches. Judged by the results of recent experience with ferro-concrete structures, there is little to fear of the pontoon ever being seriously damaged by collision. The reasons given for the use of this material were the lower first cost, the elimination of maintenance charges, and the readiness with which possible repairs could be effected. 2,000 words.—*Engineering,* June 14.

French Warship Building.—A resumé of the French Naval Programme for 1913, which provides for laying down four battleships, in addition to five to be advanced and two to be completed during the year, making eleven in progress of construction. The last two named are 540 feet in length, and at 29 feet draft displace 23,100 tons, with Parsons turbines of 28,000 shaft horsepower to give a speed of 20 knots. In the five battle ships now in progress, the general dimensions are the same, but 500 tons more displacement is to be allowed at the same draft, and in consequence the Parsons turbines will be 29,250 shaft horsepower to give 20 knots. No cruisers are provided for, and as regards the torpedoboat destroyer programme, nine vessels are to be completed next year, seven of them at private works and two at dockyards, three will be continued and three will be laid down. These are twin-screw turbine-driven ships 265 feet 9 inches in length and 850 tons displacement. Of submarine boats, eight will be completed, ten continued and three will be commenced. The submarines are steadily increasing in size. These later vessels are to be 242 feet 9 inches long and 19 feet 8 inches breadth. Internal-combustion engines of 4,800 horsepower are to be fitted to give a surface speed of 20 knots. Miscellaneous ships included are a submarine mine-laying ship, a transport, and a gunboat. 850 words.—*Engineering,* June 14.

Test of an External-Joint Film Oil Heater at the Engineering Experiment Station, Annapolis.—The object of the test was to determine the rate of heat transmission in British thermal units per square foot of heating surface per hour per degree Fahrenheit temperature difference between the steam and oil for various steam pressures and rates of flow of oil. The size of the inner tube of the heater was 5 inches diameter and 43½ inches length between headers, having a heating surface of 6.13 square feet. The test is reported complete and is accompanied by a drawing of the heater and photographs of the apparatus as set up. The results are plotted as curves. The most economical operation of the system would seem to occur when the steam pressure is reduced until the outlet temperature is not any higher than necessary for the operation of the burners. 4,200 words.—*Journal of the American Society of Naval Engineers,* May.

The Corrosion of Bronze Propeller-Blades.—By William Ramsay, F. I. C. An examination of several specimens of bronze propeller-blade corrosion, which are divided into three or four types, classified by the position on the blades. In a previous study of this subject by the same author, the causes were stated to have been mechanical erosion. Attempts to counteract this action by improved alloys have not been entirely successful. In this study the effects of electrolytic corrosion upon metals under heavy stress are shown to be capable of causing the trouble. This has been shown, among other ways, by a simple experiment upon two bent pieces of sheet metal immersed in sea water and coupled to a delicate galvanometer. A strain upon one increases its electromotive force, the increase being greater if the stresses were vibratory. Immersed in an electrolyte an electric current will flow between the two parts, the strained metal being attacked or dissolved, while the unstrained metal is comparatively unaffected. In the latest type high-speed turbine propellers, these injurious conditions are very much intensified, and in conjunction with the thinning away of the blade sections, soon makes corrosion dangerous, as has several times actually occurred. The remedy is mainly one of design. Although the metallurgist may improve matters a little, the principal correction is increased blade sections and weight of hubs and wheels as a whole. 3,400 words. Well illustrated.—*Engineering,* May 24.

Converted into Oil-Burners.—The passenger steamers *Prince Rupert* and *Prince George,* of the Grand Trunk Pacific Steamship Co., have been converted to oil-burners. The work has been done at the yards of the British Columbia Marine Railways Co., Esquimalt, B. C., under the supervision of Capt. C. H. Nicholson, manager of the Grand Trunk Pacific Steamship Co. fleet. Owing to the exceptionally large fresh water supply required by these ships, the double bottom tanks are used for its storage and so oil fuel was stored in tanks built in the usual bunker space. Ample fuel space has been installed for a steaming radius of 1,700 nautical miles at 18 knots. The oil-burning system adopted was the Dahl, manufactured by the Union Iron Works of San Francisco. The line has provided a storage tank at Vancouver with a capacity of 32,000 barrels, with a measuring tank of 1,000 barrels capacity and a pumping plant of over 1,000 barrels an hour. Diagram drawings of general arrangements of ships as changed. 2,200 words.—*The Marine Review,* June.

Auxiliary Machinery for Internal Combustion Engined Vessels.—By W. R. Cummins. Second only to the question of the practicability of the Diesel engine itself is that of the auxiliaries for such vessels. The aim of this paper is to show how every auxiliary on board ship, and including steering engine and winches, might be satisfactorily worked without the auxiliary steam line usual in steam-propelled vessels. Each individual auxiliary is taken separately and the solution worked out. Later the whole system is taken as a whole and the advantages inherent in electric, compressed air, and hydraulic power are compared. The electrical solution is said to be entirely practicable; a few good things are said for compressed air, but the efficiency generally is lower than with the electricity, while little was said to justify the adoption of hydraulic system. The paper was followed by a lengthy discussion. In all, 20,000 words. Illustrated.—*Transactions Institute Marine Engineers,* April.

The Brown-Curtis Turbine.—H. M. S. *Southampton,* the latest of the Town class of cruisers, was launched on May 16 from the Clydebank works of Messrs. John Brown & Co., Ltd. This vessel is the third of the class to have Brown-Curtis turbines which have proven very satisfactory both on trial and in service. So favorably is this type considered that the Admiralty accepted the proposal to use it in the latest battle-cruiser *Tiger* recently placed with the same firm. This vessel is to be 698 feet long, 90 feet 6 inches beam, and will displace 28,000 tons. The speed is to be 28 knots, which will require 80,000 indicated horsepower.—*Engineering,* May 24.

The Sperry Gyro-Compass.—An extensive description of the mechanism of this complicated instrument. Fully illustrated by detail and assembly drawings and photographs. Its purpose is to provide the necessity of a true compass by mechanical means, this being done through the gyroscopic action of a wheel rotated in a vacuum by an electric motor, and so supported as to be serviceable under any conditions incident to navigation, and so mounted as to be readily used in a binnacle very similar to the usual form. The instrument is manufactured by the Sperry Gyroscope Co., of New York, and has already been installed on several United States warships. 4,200 words.—*Engineering,* May 31.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By ALDRICH PUBLISHING COMPANY, INC.

H. L. ALDRICH, President and Treasurer

Assoc. Member of Council, Soc. N. A. and M. E.

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

Assoc. I. N. A.

H. H. BROWN, Editor

Member Soc. N. A. and M. E.; Assoc. I. N. A.

AMERICAN REPRESENTATIVES

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

Circulation Manager, H. N. Dinsmore, 37 West Tremlett St., Boston, Mass.

Branch Office: Boston, 643 Old South Building, S. I. Carpenter.

Entered at New York Post Office as second-class matter.

Copyright, 1912, by Marine Engineering, Inc., New York.

International Marine Engineering is registered in the United States Patent Office.

Copyright in Great Britain, entered at Stationers' Hall, London.

Notice to Advertisers.

Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

Many of the recent proposals for the development of shipbuilding in both the United States and Great Britain designed to take advantage of traffic through the Panama Canal have been held up awaiting the final action of the present session of Congress regarding the Panama Canal tolls. Without advance knowledge as to the exact conditions under which traffic through the canal would be conducted, it has been impossible to go forward with any preparations for such traffic, but now that this important measure has become a law there is no necessity for further delay in the progress of such plans as are feasible under the existing conditions. In signing the Panama Canal bill as finally modified by the Senate and House, President Taft expresses a very favorable opinion of the measure, stating that the bill is admirably drawn for the purpose of securing the proper maintenance, operation and control of the canal and the government of the Canal Zone and for the furnishing to all patrons of the canal, through the government, of the requisite docking facilities and the supply of coal and other shipping necessities. The features of the bill to which objection has already been made and which may be the subject of further legislation are those relating to the discrimination in favor of the coastwise trade of the United States, the clause prohibiting railroad-owned ships from passing through the canal and the amendment that bars out trust-owned ships. As there is a considerable interval, however, before the canal is finally open for traffic it is probable that any features in this preliminary legislation which prove undesirable for the best interests of commerce will be modified to meet specifically the existing conditions. On the whole, the enactment of this bill should prove a decided stimulus to the industry of shipbuilding.

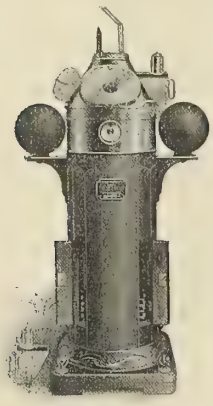
While conditions on the Great Lakes are quite different from those in ocean shipping on account of the continual movement of vast quantities of a specific bulk cargo, such as ore or coal, over certain routes, yet the development of special types of vessels for this traffic has brought out some original features of ship construction that may eventually prove useful in a modified form for adoption in sea-going vessels, especially in bulk freighters. A notable example of the modern bulk freighter is given this month in the description of the new vessels built by the Great Lakes Engineering Works for the Shenango Steamship & Transportation Company. These vessels, while the largest of their type in the world, are designed for only a moderate speed, and consequently require only a comparatively small power for propulsion. But notwithstanding the small machinery weight necessary for this power, no refinement of design is sacrificed which would increase the efficiency of propulsion or lower the fuel consumption. The hull itself is a splendid example of the latest type of bulk freighters, with the hold extending in an unbroken sweep forward from the machinery space, divided only by two screen bulkheads of the box girder construction, the entire deck being given up to hatches. The distinctive feature of this type of hull is the massive arch girder construction, with the hopper sides of the hold carried throughout in a prolonged slope to about one-half the depth of the hold, the lower half having vertical sides terminating on the deep double bottom, confining the cargo within reach of self-filling buckets, thus eliminating hand labor in unloading the cargo. This type of vessel, with its complement of freight-handling appliances, is a distinct American engineering achievement in marine transportation which, as a whole, has resulted in reducing the cost of transportation to a lower figure than anywhere else in the world.

It would seem reasonable to expect that after many years of development in shipbuilding the modern steamship would be almost faultless as far as the arrangement of machinery is concerned, but judging from the experiences of many practical marine engineers there is usually room for improvement in this direction. We think the practical engineer is the man to be heard from on this score, and will gladly welcome criticisms from the engine room for publication, so that a better understanding may result between the shipyard draftsman and the sea-going engineer.

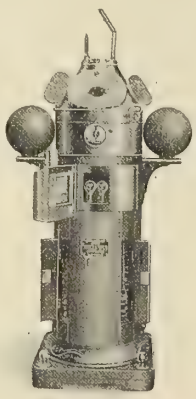
Improved Engineering Specialties for the Marine Field

Hezzanith Mark I. and Mark II. Binnacles

The binnacles, "Hezzanith Mark I. and Mark II.," illustrated on this page, which are manufactured by Messrs. Heath & Company, Ltd., Crayford, London, E. C., embody many useful improvements. The stands, made of the best specially selected hard teakwood, are well calculated to resist the ravages of weather and temperature. The brass work is all tested for absence of magnetic material and the corrector spheres and Flinders bar are tested carefully after being demagnetized. Special attention has been given to the suspension of the compass, resulting in the present arrangement of spring suspension, which is calculated to meet the various vibratory conditions of different ships. The main suspension consists of two beam helical springs (one right-handed and one left-handed), from the ends of which is suspended a saddle piece and hanger which connects with the journal on the compass gimbal. Above these two springs is fitted a laminated bowed-blade damper spring, the function of which is to damp the superfluous vibrations of the helical springs.



"MARK I"



"MARK II"

The pressure exerted by this "damper" on the helical springs is adjustable, and can be varied from nothing at all to producing a condition approximating rigidity. This damping arrangement, which is protected by patents, is claimed to be a most practical improvement and a great factor in producing the stability in the compass card, which is so essential. The whole of this suspension is adjustable in azimuth for about 6 degrees, thus enabling the lubber line of the compass to be set absolutely on the keel-line of the ship.

Another interesting and very practical departure is the method of attaching the binnacle top to the rim. The old way was to fit lugs on the rim and then cut corresponding gaps in the beading of the top. This had two main defects: First, the cutting away of the beading weakened the top, and, second, there was always a lot of "fiddling about" with the top until the gaps were in the correct position to pass over the lugs. In the "Hezzanith" binnacles the top is provided with automatic catches and can be placed securely on the rim in any position. There are no lugs on the rim and no gaps in the beading of the top, and the rim itself consists of a strong, grooved casting instead of the usual beaded and wired sheet brass. To remove the top all that is required is the pressure of the thumbs on two plungers suitably placed close to the handles with which the top is provided.

As is well known, the Mark I. binnacle is provided with oil lamps above the compass; these are removable, and the glazed openings over which they are attached to the top are provided with brass shutters; the lamps can be attached without the shutters being removed, and thus there is no fear of loss of parts. In the Mark II. binnacle the lighting is effected by oil and electric lamps placed below the compass, the compass being transparent to enable the card to be properly illuminated. In these binnacles the oil lamp, which is a new model with two powerful burners, is attached to the binnacle by a very simple and neat device, and can either be left on the binnacle when using the electric light, or, if desired, can be removed, in which case a brass panel slides over the lamp opening. The electric light is provided with a special reducing switch, very useful in taking azimuth observations.

The compasses in both models are provided with suitable viscous fluid chambers, which it is claimed effectively damp all excessive oscillations. The light cards are of specially registered design and give excellent results. If desired, liquid compasses can be fitted to these binnacles, in which case the cards are of small diameter compared with the bowl and have short needles for the purpose of correct compensation. A large magnifier is attached to the compass, which doubles the apparent size of the card. The azimuth instruments and sighting devices are all of improved form, ensuring great accuracy.

A modification of the Mark II. binnacle is the Mark II. "Torpedo" binnacle with an 8-inch liquid compass, which is extra strong and has special arrangements for reducing the light as desired and shutting off all stray beams. A spotting lamp fitted to the top focuses a single beam of light on the lubber line; it can thus be illuminated both above and below with both oil and electric lamps.

Cumberland Electrolytic Process

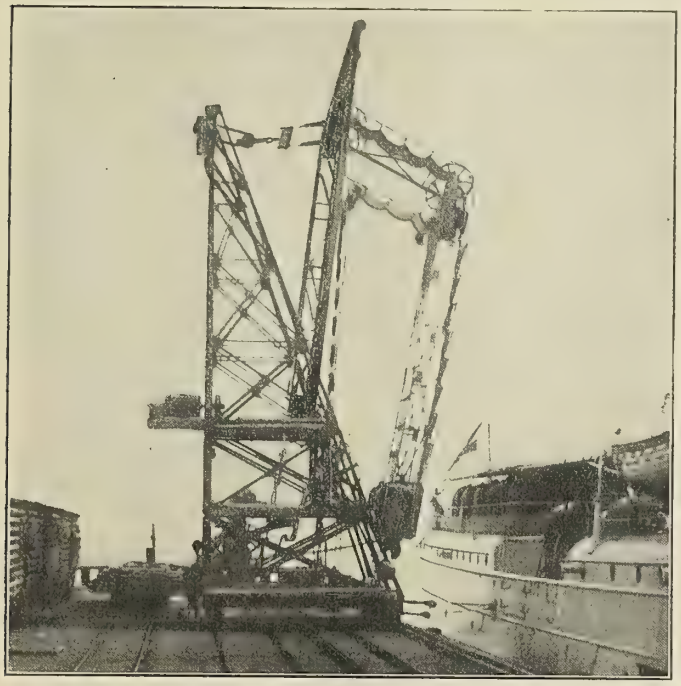
The Submarine Signal Company, Boston, Mass., has secured the right to manufacture and install throughout the United States the Cumberland Electrolytic Process, which is a system for the protection of metals from corrosion, pitting, grooving and formation of scale in steam boilers, feed-water heaters, surface condensers, tanks, etc.

This process is claimed to be a natural, permanent remedy of such troubles. It is a method of electrically protecting metallic bodies wherever oxidization may take place. As oxygen is the destructive agent the Cumberland Electrolytic Process produces hydrogen on the body to be protected. This is done by the following means. An electrode of the positive sign is placed near the body affected, and a determined amount of current from the positive electrode is passed through the medium surrounding the affected body to it. As the positive electrode is destroyed it attracts the destructive oxygen gas or acids and hydrogen gas forms on the body to be protected. The amount of electricity required is extremely small and can be regulated at will, and an instrument is provided showing the amount of energy consumed and that the metallic body is at all times protected.

Handling Bananas Mechanically

A unique mechanical appliance for loading bananas on board ship has been patented by Mr. George Edelston, of New Orleans, La. This machine travels on a trackway alongside the wharf, moving to any position alongside the vessel. The tower stands 45 feet from the wharf level, the main boom extending 35 feet. The main leg, which extends into the ship, measures 28 feet between centers, and by aid of the main, or what is termed the auxiliary boom, may be placed at a convenient distance from the wharf to any position in the hold of the vessel.

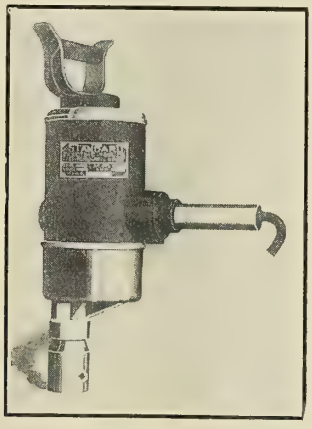
The machine is equipped with a Jeffrey conveyor, manufactured by the Jeffrey Manufacturing Company, Columbus, Ohio, consisting of double strands of Vulcan chain-carrying pockets 48 inches wide. The machine is equipped with a 10-horsepower motor for operating the booms and propelling the truck along the trackway. This same motor also operates the conveyor, although the conveyor itself does not require



more than 2 horsepower for its operation while at normal speed carrying forty-two bunches of bananas per minute. With the use of this machine the delay and drudgery by human labor are reduced, as well as the cost of loading and unloading cargoes. Vessels are now got out of the way in less than half the time than when the bananas were handled entirely by human efforts and passed into and out of the ship's hold from man to man.

High Power Electric Tools

The Standard Electric Tool Company, Cincinnati, Ohio, has developed, and is now placing on the market a line of high-



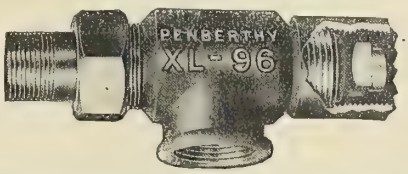
power electric tools, including ball-bearing portable drills and grinders.

In the drills all gears are generated from chrome-nickel steel, case hardened, and are mounted on ball bearings packed in grease, which are claimed to be dust proof. The very highest grade German bearings are used. The motors carry a very strong series winding, which gives them an excess of power over rated capacity, preventing overloads and burnouts. The drills are built in ⅜-inch and ½-inch sizes for direct and alternating current. The ½-inch direct-current drill is guaranteed to ream up to 7/16 inch in thick metal. In addition a Universal drill of ⅜-inch capacity that will operate on both direct and alternating-current is made. These drills are built and recommended for the most rigorous and hardest constant service. All armatures and poles in both drills and grinders are built up of the best soft electrical sheet steel and are uniformly insulated.

The grinders are made for tool post, bench and parallel work. A special feature in connection with the tool post or center grinder is a base which converts it into a bench grinder by removing a slide and placing the motor in a groove in the top of the base, as this doubles the range of work, increasing the value of the tool in all shops, because while tool-post grinders are indispensable they are used only at intervals, and by this combination they can be kept in constant service. All motors in both drills and grinders are force-ventilated by fans of special design. The grinders are furnished with phosphor bronze bearings adjustable to wear.

An Automatic Ejector

The ejector illustrated is adapted to locations unhandy of access, as in the holds of vessels and other out-of-the-way places. It may be placed under the flooring alongside the keelson or in other parts of a boat where leakage is constant or intermittent. The ejector can be relied upon to start automatically when water rises beyond permissible depths. It will work when operated with either steam or water pressure, and because of this feature it may be placed any distance from the boilers, even so far that steam will condense before



reaching it, as it will work with hot condensation, or it may be located any distance from a steam pump and be worked with water discharged by the sump. When operated with 40 pounds pressure (either steam or water) it will elevate 20 feet, and when operated with higher pressure it will elevate to proportionately greater heights.

This ejector is attached to a valve and float with levers that automatically raise the spindle of the valve when leakage of water buoys up the float and lowers the spindle, closing the valve after the ejector has emptied the leakage. The valve disk is shaped so as to control the pressure that is to operate the ejector, and is made with a diameter of valve opening exactly proportionate to the length or purchase of operating levers and the surface area of the float. This arrangement allows the device to operate automatically throughout a variable range of pressure, without the use of weights or toggles that require adjustment to different pressures.

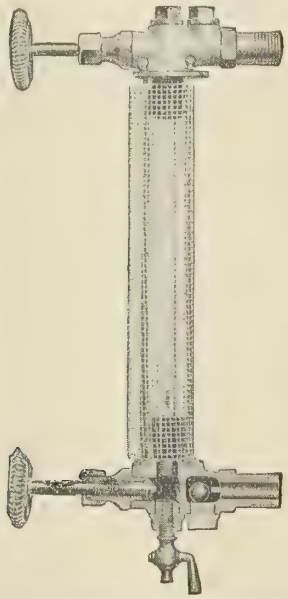
The device is manufactured by the Penberthy Injector Company, of Detroit, Mich.

Watertown Automatic Safety Water Gage

The Watertown automatic safety water gage, which is manufactured by the Watertown Specialty Company, Watertown, N. Y., is a device which it is claimed is absolutely automatic in its action in affording a positive protection from injury due to flying glass and scalding by steam and water when a water gage is broken. Between the shut-off valves and steam and water passages is a chamber containing a hard, accurately ground, bronze, non-corrosive ball, which, together with its seat, constitutes the automatic feature of the safety

device. When in operation the pressure on either side of the ball chamber is equal, so that there is no force tending to hold the ball to its seat. It then falls away from the seat and lies at the bottom of the chamber, leaving the steam and water passages to the glass entirely free.

Should the glass be broken the pressure outside the valves is released and both valves are immediately raised to their seats by the internal pressure, so that the rush of steam and water through the broken glass is positively checked. After the glass is replaced and the drain cock closed, the balls will automatically release and open the gage, as the ball seat is provided with a small grove or by-pass, which allows a slight leakage of steam and water to pass it, so that the pressure on both sides of the ball is soon equalized, and they then fall from their seats, leaving the gage in its regular operating condition.



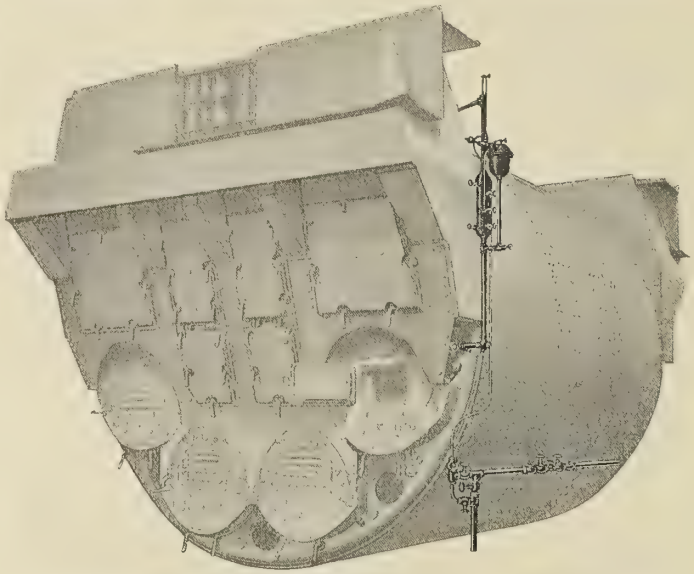
It is claimed that the ball valves cannot stick and partially close the passage, as the ball is held above the bottom of the chamber and against the valve seat by the boiler pressure, and as soon as this pressure is equalized on both sides the ball is forced by the action of gravity away from the seat, which it cannot reach again except by being raised by a strong pressure of steam.

Being simple in construction, it is a very easy matter to keep the gage in repair, and aside from occasionally cleaning the gage requires no attention.

The Vigilant Marine Feed-Water Regulator

The Vigilant Feed Water Regulator, manufactured by the Chaplin-Fulton Manufacturing Company, Pittsburg, Pa., is an apparatus designed to regulate the water level in boilers of every description. By its action it is claimed that the water level is held constantly at one point with less than ¼ inch variation, introducing the feed-water in exactly the same quantity as the steam is evaporated. It is of simple construction, so that it cannot easily get out of order, and any one who is competent to operate a boiler can easily understand its operation. The manufacturers claim that it will furnish dry steam to the engines on account of the regulation of the feed pumps, in accordance with the load on the boilers. Also, that it increases the efficiency of the heaters and economizers, maintaining a uniform temperature in the boilers, thus preventing excessive strains from contraction and expansion, and resultant leakage or the burning of fusible plugs. There are no floats or concealed parts to obscure steam passages in the apparatus, but the whole device stands in plain view and can be examined at any time without disturbing the boiler. Should any accident occur to the regulator the change to hand regulation can be accomplished in less than a minute.

The apparatus consists of three essential parts. The first is a special combination union angle valve, which must be inserted in the boiler at the point where it is desired to maintain the water level. The opening in the end of the threaded nipple, having a ½-inch pipe, is half-round, with the top horizontal, and it is the alternate submersion and uncovering



of this opening that causes the machine to operate. The second part of the apparatus is a hooded chamber, in which, and to which, is attached the operating mechanism of the regulator. Inside the chamber is suspended a displacement, hung from the end of a lever, which engages with a horizontal shaft. To the protruding end of the shaft is keyed an exterior lever carrying an adjustable cast iron counterweight. This counterweight is of such size that it weighs less than the displacement but more than the displacement when the latter is submerged. The controlling valve is the third part of the regulator, and is placed in the feed line of the boiler, usually in a by-pass, so that it can be cut out at will. In construction it is similar to a check valve.

When the water level in the column is below the opening of the special nipple, the difference in pressure on the valves of the apparatus, as controlled by the weights and steam pressure, will open the controlling valve and admit water to the boiler. When the boiler fills up to the opening of the special nipple, the stem will be sealed by the rising water, the controlling valve closed and the feed-water shut off. No more water can enter the boiler until the water falls to the opening of the special nipple. When steam is admitted to the top of the chamber the water in it falls to the old level, all the operations are reversed, and the controlling valve opens again. The operations are repeated as the water gets above or below the desired point.

Piston Rod for a 5,000 Horsepower Gas Engine, Type "A," Chrome Vanadium Steel, Heat Treated

A hollow-bore piston rod of special material was recently made by the Erie Forge Company, Erie, Pa., for a 5,000-horsepower gas engine. This rod was made of type "A" chrome vanadium steel, heat treated, and the results obtained are shown in the following table, where they are compared with the results required in the specifications:

	Results Required	Results Obtained
Carbon	.30-.35 percent	.30 percent
Chromium	1.00 percent	1.12 percent
Manganese	.46-.60 percent	.59 percent
Silicon	.12-.16 percent	.113 percent
Vanadium	.18 percent	.21 percent
Sulphur	.025 percent	.021 percent
Phosphorus	.020 percent	.012 percent
Tensile strength	110,000-130,000 lbs.	137,500 lbs.
Elastic limit	85,000-110,000 lbs.	108,000 lbs.
Elongation in 2 inches	15-25 percent	18 percent
Reduction of area	40-50 percent	46.3 percent

Technical Publications

A bibliography of all books in the English language on engineering and metallurgy published during the five years 1907-11 is announced for publication by Messrs. Grafton & Company, of 69 Great Russell street, Bloomsbury, W. C. The work has been compiled by Mr. R. A. Peddie, the librarian of the Technical Library of the St. Bride Foundation, and is arranged in alphabetical order of subjects. It will be as useful in America as in England, as both English and American publishers and prices are given. The book will be issued at $2.00 (7/6) net.

The Shipbuilder Press, Newcastle-on-Tyne, have just issued the first of their special annual international numbers (2s. 4d., post free, or 4s. 6d. in cloth), which takes the form of a world's survey of the scientific and technical progress in naval architecture and marine engineering during the past year. This is the first attempt to embody in one volume concise and comprehensive data regarding the latest practice and the results of research, investigations and experiments in every country where shipbuilding is carried on. The work contains a resumé of all the papers—nearly eighty in number—of interest to shipbuilders and marine engineers communicated to the scientific institutions of Great Britain, Germany, France, Italy, the United States, Japan, etc. The various abstracts have been so classified and edited as to afford the most convenient reference, no matter from what country received, while an elaborate index greatly enhances the value of the book. Printed in high-class style on art paper, and containing 200 pages and nearly 250 diagrams, the international number of *The Shipbuilder* should prove of great value to all who are concerned with the technical phases of the shipbuilding and marine engineering industry, and particularly to those British readers who are unable to study in the original the papers presented to the German, French, Italian and Japanese societies, which, as contributions to the literature of the industry, are yearly becoming more valuable.

Diesel Engines for Land and Marine Work. By A. P. Chalkley. Size, 5½ by 8½ inches. Pages, 226. Illustrations, 80. London, 1912: Constable & Company, Ltd. Price, 8/6 net.

This is practically the first book which has been devoted entirely to the subject of Diesel engines. The remarkable development of the Diesel motor in the past two years, however, makes it a very welcome addition to current engineering literature. The general principles of the Diesel engine have been stated briefly in almost every text-book on thermodynamics and heat engines in recent years, but very little information has been available regarding the mechanical features of the Diesel engine; in fact, these have changed so rapidly and have been developed in so many different ways for different purposes, both on shore and afloat, that a comprehensive description of modern Diesel engines could be made only by the compilation of a vast amount of data from many sources. In the present volume, however, this work has been thoroughly done, and there is hardly any successful type of Diesel engine which is not fully described in the book. The first few chapters take up the general theory of heat engines with special reference to Diesel engines and the action and working of the Diesel engine. Following this the reader's attention is turned to the actual construction, installation and running of Diesel engines, and also some data from tests of Diesel engines are given. The final chapters discuss the marine Diesel engine, and are profusely illustrated with photographs and line drawings of the principal marine installations. A very attractive future for this type of engine is suggested, and with the optimistic introduction, written by Rudolf Diesel, the inventor of the engine, the reader will be induced to make a careful study of the contents of the book.

Efficiency as a Basis for Operation and Wages. Third Edition. By Harrington Emerson. Size, 5 by 7¼ inches. Pages, 254. New York, 1912: *The Engineering Magazine*. Price, $2.00.

The fundamental principles of Mr. Emerson's interpretation of efficiency, as applied to industrial affairs, have been before the public for several years, but before the third edition of his work on this subject was published he made a thorough revision of the text, elucidating points upon which experience had shown added emphasis must be laid, adding sections to cover the development of thought and practice since the first draft was written, and establishing points of connection between this volume and the one shortly to follow on "The Twelve Principles of Efficiency." The principal changes will be found in the chapters on "Line and Staff Organization in Industrial Concerns," "Standards" and "The Modern Theory of Cost Accounting."

Heat and Thermodynamics. By F. H. Hartmann. Size, 6 by 9 inches. Pages, 346. Illustrations, 72. New York, 1911: McGraw-Hill Book Company. Price, $3.00 net.

Most books on thermodynamics, and there are many, are written by teachers to meet the needs of the particular class of students under their tutelage. For this reason the subject has been treated in a variety of ways, each of which detracts in no way from the value of the others, but which adds rather to the sum total of available information on the subject. In this case the author distinctly points out in the preface of the book that he had no expectation that his treatise would supersede the admirable standard works on this subject, but that it should serve rather as a proper preparation for the reading of such works. It differs from the others, however, in that the first part of the book is given over to a comprehensive discussion of the fundamental principles of heat measurements, information without which the student cannot make much headway in the study of thermodynamics, and which cannot be obtained easily from lengthy text books on physics or heat. With such a helpful start as can be gained from the study of this valuable part of the book many of the difficulties of the student have been overcome and the subject of thermodynamics can be approached much more readily.

The New Navy of the United States. By N. L. Stebbins. Size, 9 by 7 inches. Pages, 160. Illustrations, over 200. New York, 1912: Outing Publishing Company. Price—cloth bound, $1.50; morocco binding, $2.00.

This book is really a collection of pictures of what is called by the author "Our New Navy." The pictures are supplemented by sufficient descriptive matter to give the reader a good idea of the main details of the vessels illustrated. Most of the pictures are reproductions of photographs made by the author himself, many being the official photographs made at the trials of the ships. The excellent work of the author as a marine photographer is well known to readers of International Marine Engineering from the numerous examples of his work which have appeared in this journal during the last decade. In this book, however, the photographs are reproduced on a larger scale on a fine quality of paper, which adds much to their pictorial value. It has been impossible to procure photographs of all the vessels of the navy, and so the aim has been to show representative types. The data accompanying the pictures have been compiled from official publications and carefully revised and corrected by competent authorities, so that the author's hope that the volume will prove not only of interest to the general public but also as a reliable book of reference by those immediately interested in naval affairs seems well justified. A patriotic introduction is contributed by Admiral George Dewey, admiral of the United States navy, and an interesting article describing the scope of the Revenue Cutter Service is contributed by Capt. Preston H. Uberroth, R. C. S.

Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,022,432. MECHANISM FOR PREPARING BOATS FOR LAUNCHING. JOHN McGOLDRICK, OF BALTIMORE, MD.

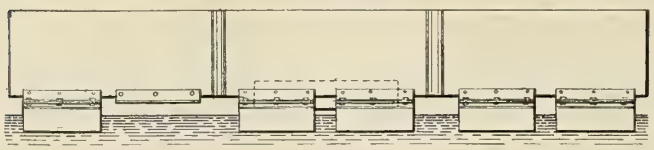
Claim 1.—In a boat-releasing device, the combination with a boat and its cover, and chocks for the boat, of means for securing the boat and cover together, gripes for holding the boat upon the chocks and controlling the position of the said chocks and means for simultaneously releasing the boat from the cover and from the gripes whereby the chocks are also released. Seven claims.

1,022,486. HEATER FOR AUTOMOBILE TORPEDOES. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

Claim 1. In a torpedo, a containing vessel divided by a partition into water and fuel compartments, a source of compressed air, and means for conducting compressed air under equal pressures into both compartments. Ten claims.

1,022,931. FLOATING DRY-DOCK. ANDREW C. CUNNINGHAM, OF WASHINGTON, DISTRICT OF COLUMBIA.

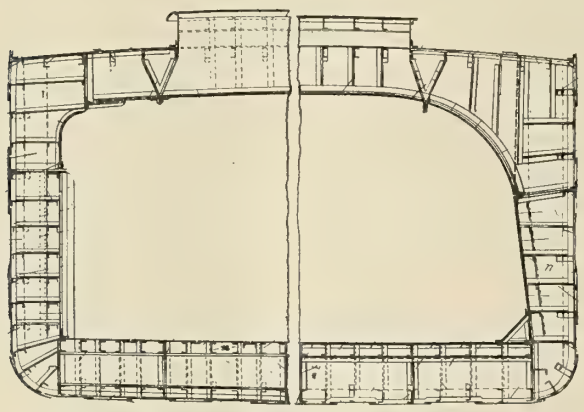
Claim 1.—In a floating dry-dock, a plurality of sections comprising pairs of parallel upright side walls connected end to end in detachable



relation with each other, and a plurality of transverse pontoons underlying and supporting each pair of side walls, said pontoons being interchangeable with respect to the several pairs of side walls. Six claims.

1,020,365. SHIP CONSTRUCTION. JOSEPH R. OLDHAM, OF CLEVELAND, OHIO.

Claim 1.—In a ship or vessel construction, transverse web plates having perforations near their outer margins, longitudinal frames or girders, notched at intervals adapted to be inserted in the perforations of the web plates, the uncut outer margins of the web plates and bars seated in



the notches of the longitudinal frames, the edges of said frames or girders being brought to a position in contact with the shell or deck plating, or flush with the edges of the web plates; filling bars inserted in the perforations abreast of the notches in the longitudinal frames or girders, transverse angle bars and bracket plates for securing said parts together. Ten claims.

1,023,907. MECHANICAL AIR DEVICE FOR EXPELLING WATER OR OTHER LIQUIDS FROM THE HEADS OF TORPEDOES TO AID IN THE RECOVERY THEREOF AFTER FIRING. KENNETH WHITING AND JAMES B. HOWELL, OF THE UNITED STATES NAVY.

Claim 1.—In an automobile torpedo provided with a head, the combination of an air flask located in said head and provided with a passage discharging in said head; a valve controlling said passage; a trigger lever controlling said valve; means controlling said trigger lever to retain said valve closed; additional means adapted to be actuated by pressure due to submergence for releasing said first mentioned means; and a discharge valve in said head adapted to permit water to escape therefrom. Six claims.

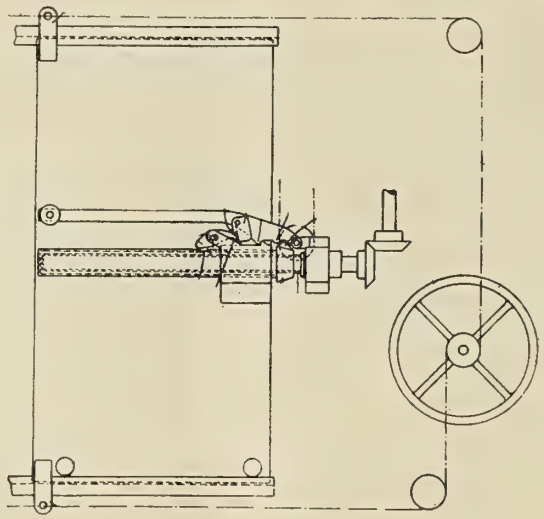
1,024,664. SUCTION TUBE FOR HYDRAULIC DREDGING-MACHINES. LOUIS J. BALTZ, OF BUFFALO, N. Y.

Claim 1.—In an apparatus the combination of a suction tube restricted at one point, a pivoted crusher-jaw wholly confined within said tube and arranged adjacent said destricted point, and means for oscillating said crusher-jaw. Seven claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

28,938. MECHANISM FOR OPENING AND CLOSING WATER-TIGHT DOORS FOR SHIPS' BULKHEADS OR THE LIKE. C. KLOCK, OF SCHAARSTEINWEGSBRUECKE, 2, WELSERHAUS, HAMBURG, GERMANY.

Claim.—By this invention the means of suspension are simplified and springs and other unavoidable mechanism eliminated. The improvements may be also applied to horizontally sliding doors. This door may be closed by raising a lever, by turning a spindle, or by manipulating a rope from any part of the ship. In any case the door is dropped on raising the lever. If the screw be turned to move the nut downward the lug presses the nose and throws up the lever, so disengaging the catch on the door, which can then fall. The nut has a long square-



sleeve extension, which still engages the door and prevents the turning of the nut at its lower end, and the screw is rotated until the nut presses the door home. It will be seen that the pin is now to the left of the lever-arm, so that when the nut descends the latch can engage the notch of the sleeve, and on turning the screw in the opposite direction the door is raised until the lever is moved outward by the projection so that the pin and pawl move into the position shown, in readiness for an emergency.

11,404. DEVICES FOR PREVENTING THE STRANDING OR COLLISION OF VESSELS. G. BONIFACIO, KRAUS, BERLIN, AND F. KREIGBAUM, DUSSELDORF.

Claim.—By this invention a pilotboat is driven and steered electrically from the ship and provided with contact devices which, upon striking an obstacle, electrically transmits signals to the ship. An auxiliary device indicates any deviation of the boat from the course and preferably steers it. The pilotboat has a bent lever and a grapnel suspended from it, which serve to catch submerged objects, such as ropes of other vessels having like safety devices, and by closing a circuit they operate signaling, stopping or reversing devices. The boat also has a sounding device suspended from a drag-rope and having feelers which, upon striking the bottom, close a circuit to operate the signaling, etc., device. This sounder is enclosed by an elastic cover to prevent intrusion of sand, mud, etc. The sides of the boat also have feelers with flaps which protect them and allow them to be actuated without directly touching an obstacle. The motion of two steering electro-motors is transmitted to the rudder by gears engaging a common toothed segment connected by ropes with the rudder, each motor moving the rudder in one direction only. The rope connecting the pilotboat with the vessel is supported on the latter by levers which, upon the deflection of the rope in either direction, by closing electric circuits, give indications of the altered course or operate the steering device of the pilotboat. The rope connecting the pilotboat with the vessel, and containing the leads, is constructed so that it will float.

11,820. LAUNCHING OF LIFEBUOYS. J. P. KIERAN, LIVERPOOL.

Claim.—By this invention the buoy is carried in a cage fastened to the deck rails and rests on the hinged bottom of it so that when the fastening is withdrawn by means of a cord the bottom swings downward and allows the buoy to fall into the water. Counter-weighted flags are attached, also a flare ignited by the automatic breaking of the seal, and these indicate the position of the buoy when afloat.

3,615. BALANCING THE THRUST OF PROPELLER AND LIKE SHAFTS. W. KNEEN, LONDON.

Balancing the thrust is effected by means of rollers mounted on bell-crank levers and running on a thrust-collar clamped to the propeller shaft. The cranked levers are pivoted to the ship at their middle and their extremities, farthest from the rollers, bear against helical springs which allow the rollers to yield to excess pressure. Ball-bearings may be used instead of rollers.

15,788. PILES, PIERS, WHARVES AND LIKE STRUCTURES. R. THOMSON, GLASGOW.

The invention relates to a pile or the like of reinforced concrete sunk by driving with or without water jets. Being set in positions, the base is filled in with concrete to form a solid mass that will efficiently support the load.